

**Silicon Institute of Technology**  
| An Autonomous Institute |

# **Curriculum Structure and Detailed Syllabus**

**Bachelor of Technology  
in  
Electronics & Communication Engineering**



**Department of Electronics & Communication Engineering  
Silicon Institute of Technology  
Silicon Hills, Patia, Bhubaneswar - 751024**

*Effective from Academic Year 2018-19*  
Build: 1.30 (31-08-2023)

## Approval History

<b>ACM#</b>	<b>Date</b>	<b>Resolutions</b>
AC-1	14/08/2018	The curriculum & detailed syllabus of 1st Year, as proposed by the Board of Studies, is provisionally approved by the Academic Council.
AC-2	11/05/2019	The curriculum & detailed syllabus up to 2nd Year, as proposed by the Board of Studies, is approved by the Academic Council.
AC-3	28/09/2019	The amendments to the curriculum as suggested by the Boards of Studies, along with the proposal for provision of Practice School in the 4th year of B.Tech. is approved in principle by the Academic Council.
AC-4	18/08/2020	The curriculum & detailed syllabus up to 4th Year as suggested by the Boards of Studies, along with provision of Practice School in the 4th year is approved by the Academic Council.

## Program Outcomes (UG Engineering)

Graduates Attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The Program Outcomes (POs) for UG Engineering programmes defined by NBA are:

- PO1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
- PO2. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO3. **Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO4. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- PO5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- PO6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- PO7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- PO10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- PO12. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## Program Educational Objectives (PEOs)

- PEO1. *Fundamental Knowledge & Core Competence*: To provide knowledge of science and engineering fundamental for an electronics & communication engineer and equip with proficiency of mathematical foundations and inculcate competent problem solving ability.
- PEO2. *Competency for Real World*: To design, optimize and maintain electronics and communication systems in tune with community needs and environmental concerns.
- PEO3. *Professionalism & Social Responsibility*: To exhibit leadership capability, triggering social and economical commitment and inculcate community services and protect environment
- PEO4. *Life-long Learning*: To pursue higher studies or engage in a technical or managerial role in diverse teams, grow professionally in their career through continued education & training of technical and management skills.

## Program Specific Outcomes (PSOs)

- PSO1. Apply fundamentals of mathematics, science and engineering knowledge, and hardware and software tools to identify, investigate, design, and implement solutions to complex computing problems.
- PSO2. Understand the impact of professional behavior & ethics, and communicate effectively with the engineering community and the society.
- PSO3. Engage in life-long learning and work effectively as an individual as well as in a team comprising of professionals from multiple disciplines.

## Course Types & Definitions

L	Lecture
T	Tutorial
P	Laboratory / Practical / Sessional
WCH	Weekly Contact Hours
BS	Basic Sciences
HS	Humanities & Social Sciences (including Management)
ES	Engineering Sciences
PC	Professional Core
PE	Professional Elective
OE	Open Elective
MC	Mandatory Course
CC	Compulsory Course
PJ	Summer Internship / Project Work / Seminar
PS	Practice School / Industry Internship
VV	Viva Voce

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**Part I**

**1st Year B. Tech.**  
**(Common to All Branches)**



## Curriculum Structure

Semester I								
Type	Code	Course Title	WCH L-T-P			Credits L-T-P		
<b>THEORY</b>								
BS	18BS1T01	Engineering Mathematics-I	3	0	0	3	0	0
BS	18BS1T05/ 18BS1T06	Engineering Chemistry/ Engineering Physics	3	0	0	3	0	0
ES	18ES1T01/ 18ES1T02	Basic Electronics Engineering/ Basic Electrical Engineering	2	0	0	2	0	0
ES	18ES1T03	Computer Programming	3	0	0	3	0	0
HS	18HS1T01	Communicative & Technical English	3	0	0	3	0	0
MC	18NC1T01/ 18NC1T02	Constitution of India/ Environmental Science & Engineering	2	0	0	0	0	0
<b>PRACTICAL</b>								
BS	18BS1L05/ 18BS1L02	Engineering Chemistry Lab/ Engineering Physics Lab	0	0	2	0	0	1
ES	18ES1L04/ 18ES1L05	Manufacturing Practices/ Engineering Graphics	0	0	2	0	0	1
ES	18ES1L01/ 18ES1L02	Basic Electronics Engineering Lab/ Basic Electrical Engineering Lab	0	0	2	0	0	1
ES	18ES1L03	Computer Programming Lab	0	0	4	0	0	2
HS	18HS1L01	Communicative & Technical English Lab	0	0	2	0	0	1
		<b>SUB-TOTAL</b>	<b>16</b>	<b>0</b>	<b>12</b>	<b>14</b>	<b>0</b>	<b>6</b>
		<b>TOTAL</b>	<b>28</b>			<b>20</b>		

**Note:** For some courses, the subjects have been mentioned as Subject-1 / Subject-2, i.e., with an OR option. Every student has to study both the subjects, however allocation of these subjects shall alternate between Semesters I and II. For example, if a student has been allocated *Engineering Chemistry* in Semester-I, then he/she will be allocated *Engineering Physics* in Semester-II, and vice-versa. The laboratory subjects will be as per the theory subjects allocated in the applicable semester. The same applies to all other courses provided with an OR option.

Semester II								
Type	Code	Course Title	WCH L-T-P			Credits L-T-P		
<b>THEORY</b>								
BS	18BS1T02	Engineering Mathematics-II	3	0	0	3	0	0
BS	18BS1T06/ 18BS1T05	Engineering Physics/ Engineering Chemistry	3	0	0	3	0	0
ES	18ES1T02/ 18ES1T01	Basic Electrical Engineering/ Basic Electronics Engineering	2	0	0	2	0	0
ES	18ES1T05	Data Structures & Algorithms	3	0	0	3	0	0
MC	18NC1T02/ 18NC1T01	Environmental Science & Engineering/ Constitution of India	2	0	0	0	0	0
<b>PRACTICAL</b>								
BS	18BS1L02/ 18BS1L05	Engineering Physics Lab/ Engineering Chemistry Lab	0	0	2	0	0	1
ES	18ES1L05/ 18ES1L04	Engineering Graphics/ Manufacturing Practices	0	0	2	0	0	1
ES	18ES1L02/ 18ES1L01	Basic Electrical Engineering Lab/ Basic Electronics Engineering Lab	0	0	2	0	0	1
ES	18ES1L06	Data Structures & Algorithms Lab	0	0	4	0	0	2
		<b>SUB-TOTAL</b>	<b>13</b>	<b>0</b>	<b>10</b>	<b>11</b>	<b>0</b>	<b>5</b>
		<b>TOTAL</b>	<b>23</b>			<b>16</b>		

**Note:** For some courses, the subjects have been mentioned as Subject-1 / Subject-2, i.e., with an OR option. Every student has to study both the subjects, however allocation of these subjects shall alternate between Semesters I and II. For example, if a student has been allocated *Engineering Chemistry* in Semester-I, then he/she will be allocated *Engineering Physics* in Semester-II, and vice-versa. The laboratory subjects will be as per the theory subjects allocated in the applicable semester. The same applies to all other courses provided with an OR option.

Type	Code	Engineering Mathematics - I	L-T-P	Credits	Marks
BS	18BS1T01		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to familiarize the students with the knowledge and concepts of curve tracing, ordinary differential equations and applications, solution of system of linear equations using matrix methods, and Eigen vectors & Eigen values of matrices with applications.
<b>Pre-Requisites</b>	A good knowledge of trigonometry along with basics of differential and integral calculus of one variable and coordinate geometry of two and three dimensions.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
Module-1	Functions and their Graphs, Asymptotes, Curvature & Curve Tracing	8 Hours
Module-2	First order ordinary differential equations and applications	7 Hours
Module-3	Second order ordinary differential equations and applications to electrical circuits	12 Hours
Module-4	Matrix algebra, system of linear equations, rank and inverse of matrices, vector space	8 Hours
Module-5	Eigen values and Eigen vectors, complex matrices, diagonalization of matrices	7 Hours
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. S. Narayan and P. K. Mittal, *Differential Calculus*, Revised Edition, S. Chand & Company, 2014.
- T2. E. Kreyszig, *Advanced Engineering Mathematics*, 8<sup>th</sup> Edition, Wiley India, 2015.

#### Reference Books:

- R1. S. Pal and S. C. Bhunia, *Engineering Mathematics*, 1<sup>st</sup> Edition, Oxford University Press, 2015.
- R2. B. V. Ramana, *Higher Engineering Mathematics*, 1<sup>st</sup> Edition, McGraw Hill, 2017.

#### Online Resources:

1. <http://www.nptel.ac.in/courses/111105035>
2. <http://www.nptel.ac.in/courses/122104017>
3. <http://nptel.ac.in/courses/122102009>
4. <http://nptel.ac.in/courses/111107063>
5. <https://www.coursera.org/learn/linearalgebra2>
6. <https://www.coursera.org/learn/differentiation-calculus>
7. <https://www.coursera.org/learn/single-variable-calculus>
8. <https://alison.com/courses/Algebra-Functions-Expressions-and-Equations>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand the graphs of functions (curves) by knowing their characteristics like asymptotes and curvature and applying those to curve tracing.
CO2	Solve first order ordinary differential equations using various methods and apply them to physical problems.
CO3	Learn methodology to Solve second order ordinary differential equations and apply them to solve applied problems of electrical circuits.
CO4	Develop understanding of the concepts and methods of system of linear equations and apply them to solve a system.
CO5	Study and use the eigen values and eigen vectors of matrices, its properties and applications.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	1								2	1	1
CO2	3	3	2	1	2								2	1	1
CO3	3	3	3	3	1								2	1	1
CO4	3	3	3	2	3								2	1	1
CO5	3	3	2	2	2								2	1	1

Type	Code	Engineering Chemistry	L-T-P	Credits	Marks
BS	18BS1T05		3-0-0	3	100

<b>Objectives</b>	The purpose of this course is to emphasize the relevance of fundamentals and applications of chemical sciences in the field of engineering. The contents have been conceived in taking into account appropriate combinations of old and new emerging concepts in the chemical sciences area and their current and potential uses in engineering. The course attempts to address the principles of general chemistry and specific topics relevant to various engineering disciplines, so that the students can apply the knowledge in their respective areas of expertise.
<b>Pre-Requisites</b>	Basic knowledge on Normality, Molarity, mole concept, types of chemical reactions, and elementary idea on electrochemistry.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
	Introduction & Pre-requisites	2 Hours
<b>Module-1</b>	<b>Water Treatments:</b> Types of hardness-Units, Alkalinity of water and its significance, Softening methods and Numerical problems based on these methods; Membrane-based processes; Dissolved Oxygen, Problems with Boiler feed water and its treatments.	6 Hours
<b>Module-2</b>	<b>Corrosion Science:</b> Definition and scope of corrosion, Dry and wet corrosion; Direct chemical corrosion, Electrochemical corrosion and its mechanisms; Types of electrochemical corrosion, (differential aeration, galvanic, concentration cell); Typical Electrochemical corrosion like Pitting, Inter-granular, Soil, Waterline; Factors affecting corrosion, Protection of corrosion.	7 Hours
<b>Module-3</b>	<b>Industrial Lubricants:</b> Lubricants-Concept of tribology; Types of lubricants and Mechanism of lubrication, Physical and Chemical properties of lubricants, Additives of lubricants, Selection of lubricants, Flash Point, cloud point, freezing points of lubricants.	5 Hours
<b>Module-4</b>	<b>Instrumental Techniques:</b> Fundamentals of Spectroscopy; Principles and applications of molecular spectroscopy (such as UV-visible, IR and microwave).	6 Hours

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Energy Sciences:</b> Types of fuels, Calorific value, Determination of Calorific value, Combustion and its calculations, Solid fuel: Coal analysis (Proximate and ultimate analysis), Elementary ideas on some gaseous fuels (Natural gas, Water gas, Producer gas, LPG) (Synthesis is excluded), Liquid fuels: IC engine fuel, concept of knocking, antiknocking, octane No and cetane No, Fractional Distillation of petroleum, Cracking of heavy oils; Battery technology – Fundamentals of primary & Secondary cells, Rechargeable batteries: Lead acid storage battery, Lithium ion battery, Fuel cells: principles, applications. Elementary idea on Photovoltaics.	10 Hours
Module-6	<b>Nanochemistry:</b> Nanomaterials, Synthesis of noble metal nanoparticles (e.g., Gold /silver) and oxide based nanoparticles (e.g., cuprous oxide/zinc oxide) using green synthetic route, Stabilization of nanoparticles using capping agents, Elementary ideas on characterization of nanoparticles (X-ray Diffraction (XRD) and electronic spectroscopy), applications of nanomaterials.	6 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. Jain & Jain, *Engineering Chemistry*, 16<sup>th</sup> Edition, Dhanpat Rai Publishing Company, 2015.
- T2. G. A. Ozin & A. C Arsenault, *Nanochemistry - A Chemical Approach to Nanomaterials*, RSC Publishing.
- T3. C. N. Banwell, *Fundamentals of Molecular Spectroscopy*, 3<sup>rd</sup> Edition, McGraw Hill.

**Reference Books:**

- R1. S. S. Dara, *Engineering Chemistry*, 12<sup>th</sup> Edition, S. Chand Publisher, 2014.
- R2. Wiley-India Editorial Team, *Engineering Chemistry*, 2<sup>nd</sup> Edition, Wiley India.
- R3. J. M. Lehn, L. Cademartiri, *Concepts of Nanochemistry*, 1<sup>st</sup> Edition, Wiley-VCH, 2009.
- R4. Y. R. Sharma, *Elementary Organic Spectroscopy*, S Chand & Co Ltd., 2013.

**Online Resources:**

1. [https://chem.libretexts.org/Core/Analytical\\_Chemistry/Electrochemistry/Exemplars/Corrosion/Corrosion\\_Basics](https://chem.libretexts.org/Core/Analytical_Chemistry/Electrochemistry/Exemplars/Corrosion/Corrosion_Basics)
2. <https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/spectrpy/infrared/infrared.htm>
3. <http://nptel.ac.in/courses/103105110/> - Fuel & Combustion
4. <http://www.analyticalinstruments.in/home/index.html>
5. [www.edx.org/](http://www.edx.org/)
6. <https://www.ntnu.edu/studies/courses>
7. <http://www.corrosionsource.com/>
8. <http://nptel.ac.in/courses/105104102/hardness.htm>
9. [http://nptel.ac.in/courses/105106112/1\\_introduction/5\\_corrosion.pdf](http://nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf)
10. <https://alison.com> - Spectroscopic Technique, Colorimetry

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Exploit the concept of hardness in softening hard water and determining the hardness of water.
CO2	Utilize the knowledge of electrochemistry and corrosion science in preventing engineering equipments from corrosion.
CO3	Understand the characteristics of industrial lubricants, mechanism of lubrication and study kinematic viscosity & flash point of lubricating oil for application in engineering.

Cont'd...

CO4	Understand the concept of molecular spectroscopy and analyze organic compounds using spectrophotometer.
CO5	Classify various fuels based on combustion parameters and understand the working principle of various batteries.
CO6	Acquire knowledge on synthesis & characterization of oxide based & noble metal nanoparticles through green synthetic route.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	2	1	1					2	1	1
CO2	3	2	1	1	1	2	1						2	1	1
CO3	2	2	1	1	1	2	1						2	1	1
CO4	2	2	1	1	2	2	1	1					2	1	1
CO5	2	2	1	1	1	1	1						2	1	1
CO6	2	2	1	1	2	2	1	1					2	1	1

Type	Code	Engineering Physics	L-T-P	Credits	Marks
BS	18BS1T06		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to obtain basic idea about various laws and understand different phenomena using principles of physics. This knowledge will be useful for the engineering students to understand the basic operating principle of instruments and techniques. The knowledge obtained can also be used to prepare various models and projects.
<b>Pre-Requisites</b>	Adequate knowledge and clear concepts in higher secondary physics like waves, oscillations, optics, electricity, magnetism, modern physics, etc.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
	Introduction & Pre-requisites	2 Hours
<b>Module-1</b>	<b>Wave Optics:</b> Concept of wave and wave equation, Superposition of waves (two beam and multiple beam) and interference, Huygen's principle, Interference by division of amplitude and division of wavefront, Theory of Newton's rings and its applications, Diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer's diffraction from a single slit, Theory of plane diffraction grating, Determination of wavelength of light with a plane diffraction grating.	10 Hours
<b>Module-2</b>	<b>Vector Calculus:</b> Gradient of scalar field, Divergence and curl of vector field, Gauss divergence theorem and Stokes theorem (statement only). <b>Maxwell's Equations:</b> Gauss's law in electromagnetism, Faraday's law of electromagnetic induction, Ampere's circuital law, Displacement current, Maxwell's electromagnetic equations (integral and differential form). <b>Electromagnetic Waves:</b> Electromagnetic Wave (EM) equations - Free space, Dielectric and conducting medium, Transverse nature of EM wave, Electromagnetic wave in ionized medium, Electromagnetic energy density, Poynting's theorem and Poynting's vector.	11 Hours
<b>Module-3</b>	<b>Introduction to Quantum Mechanics:</b> Need of quantum mechanics, Particle nature of radiation - Black body radiation (no derivation), Photoelectric effect, Compton effect and pair production, Concept of de-Broglie's matter waves, Phase and group velocity, Heisenberg's Uncertainty principle with applications.	6 Hours
<b>Module-4</b>	<b>Schrödinger's wave equation with applications:</b> Concept of wave function $\psi$ and interpretation of $ \psi ^2$ , Schrödinger's time-dependent and time-independent equations, Probability current, Expectation values, Operators in quantum mechanics, Eigen functions and Eigen values, Applications of Schrödinger's equation- Particle in one dimensional rigid box, Potential barrier (emphasis on tunneling effect).	6 Hours

Cont'd...



Module-#	Topics	Hours
Module-5	<b>Laser:</b> Radiation-matter interaction, Absorption of light, Spontaneous and stimulated emission of light, Population inversion, Types of Laser-Solid State Laser (Ruby), Gas Laser (He-Ne), Properties and applications of Laser. <b>Optical Fiber:</b> Structure and Principle, Types of optical fiber, Numerical aperture, Applications of optical fiber.	7 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. D. R. Joshi, *Engineering Physics*, 1<sup>st</sup> Edition, Tata McGraw-Hill Publication, 2017.  
 T2. Md. M. Khan and S. Panigrahi, *Principle of Physics*, Vol. I & II, Cambridge Univ. Press.

**Reference Books:**

- R1. A. Ghatak, *Optics*, Tata McGraw Hill.  
 R2. B. S. Agarwal, *Optics*, Kedar Nath Rama Nath & Co.  
 R3. S. Prakash, *Electromagnetic Theory and Electrodynamics*, Kedar Nath Ram Nath & Co.  
 R4. D. J. Griffith, *Introduction to Electrodynamics*, Pearson Education.  
 R5. R. Eisberg and R. Resnick, *Quantum Physics of Atoms, Molecules, Solids, Nuclei & Particles*, John Wiley Publications.  
 R6. A. Beiser, *Concept of Modern Physics*, McGraw Hill.  
 R7. R. K. Gour and S. L. Gupta, *Engineering Physics*, Dhanpat Rai Publications.

**Online Resources:**

- <https://ocw.mit.edu/courses/physics/8-04-quantum-physics-i-spring-2013/>
- <http://www.ilectureonline.com/lectures/subject/PHYSICS>
- <https://ocw.mit.edu/courses/physics>
- <https://nptel.ac.in/courses/115102026/>
- <https://nptel.ac.in/courses/113104012/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Analyze wave properties of light like interference and diffraction and apply them in communications
CO2	Develop Maxwell's equations from basic laws of electromagnetism and apply them to understand the properties of electromagnetic waves.
CO3	Analyze wave-particle duality to understand radiation-matter interaction
CO4	Develop and apply Schrödinger's equations to diverse fields like bound particle, potential barrier etc.
CO5	Investigate the basic principle, properties, operations and applications of laser & optical fibre in different fields like communication, industry, medicine, research etc.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1								1	3	1	2
CO2	3	2	1	2	1							1	3	1	1
CO3	3	2		1								1	2	1	2
CO4	3	2		1								1	3		1
CO5	3	3	1	2	1							1	3	1	2

Type	Code	Basic Electronics Engineering	L-T-P	Credits	Marks
ES	18ES1T01			2-0-0	2

<b>Objectives</b>	Know broadly the concepts and functionalities of the electronic devices, tools and instruments. Understand general specifications and deployability of the electronic devices, and assemblies. Develop confidence in handling and usage of electronic devices, tools and instruments in engineering applications.
<b>Pre-Requisites</b>	Knowledge on intrinsic and extrinsic Semiconductors, Physics and Chemistry of Higher Secondary Science level.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, and planned lectures to make the sessions interactive with problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction to Electronics:</b> Signals, Frequency spectrum of signals, Analog and digital signals, Amplifiers, Digital logic inverters. (2 Hours) <b>Diodes and Applications:</b> Semiconductor Diode - Ideal versus Practical, Resistance Levels, Diode Equivalent Circuits, Load Line Analysis; Diode as a Switch, Diode as a Rectifier, Half Wave and Full Wave Rectifiers, Breakdown Mechanisms, Zener Diode – Operation and Applications; Clipper and Clamper Circuits. Opto-Electronic Devices – LEDs, Photo Diodes and Applications (8 Hours)	<b>10 Hours</b>
<b>Module-2</b>	<b>Bipolar Junction Transistor (BJT):</b> Construction, Operation, Amplifying Action, Common Base, Common Emitter and Common Collector Configurations, Operating Point, Fixed and Voltage divider Biasing Configurations.	<b>5 Hours</b>
<b>Module-3</b>	<b>Field Effect Transistor (FET):</b> Construction, Characteristics of Junction FET (JFET), Depletion and Enhancement type Metal Oxide Semiconductor FETs (MOSFET), Fixed and Voltage divider Biasing Configurations, Introduction to Complementary MOS (CMOS) circuits.	<b>5 Hours</b>
<b>Module-4</b>	<b>Operational Amplifiers and Applications:</b> Introduction to Op-Amp, Differential Amplifier Configurations, Basics of Op-Amp, Characteristics of Ideal Op-Amp, CMRR, PSRR, Slew Rate; Block Diagram and Pin Configuration of IC 741 Op-Amp, Applications of Op-Amp as: Summing Amplifier, Difference Amplifier, Differentiator, Integrator.	<b>4 Hours</b>
<b>Module-5</b>	<b>Feedback Amplifiers:</b> Principle, Advantages of Negative Feedback, Different Feedback Topologies. <b>Oscillators:</b> Classification, RC Phase Shift Oscillator, High Frequency LC Oscillator.	<b>4 Hours</b>
<b>Total</b>		<b>28 Hours</b>

#### Text Books:

- T1. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 11<sup>th</sup> Edition, Pearson Education.

T2. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, 7<sup>th</sup> Edition, Oxford University Press.

#### Reference Books:

- R1. A. Agarwal and J. Lang, *Foundations of Analog and Digital Electronic Circuits*, 1<sup>st</sup> Edition, Morgan Kaufmann, 2005.  
 R2. V. K. Mehta and Rohit Mehta, *Principles of Electronics*, 3<sup>rd</sup> Edition, S. Chand Publishing, 1980.

#### Online Resources:

1. <http://www.electrical4u.com/circuit-analysis.htm>
2. <http://www.allaboutcircuits.com>
3. <https://www.electronics-tutorials.ws/>
4. <https://www.edx.org/course/circuits-electronics-1-basic-circuit-mitx-6-002-1x-0>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Become familiar with basic signals, diodes and their applications.
CO2	Investigate on the operation of different configurations of bipolar junction transistor. Analyze and design different biasing configurations with their applications.
CO3	Understand the construction, operation and characteristics of JFET and MOSFET. Analyze and design different biasing configurations with their applications.
CO4	Learn the construction and characteristics of Op-Amp and design circuits for various applications using Op-Amp.
CO5	Understand different types of feedback topologies and design various kinds of oscillators.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1										1		
CO2	3	2	3	1									3		
CO3	2	2	2	1									2		
CO4	3		3										3		
CO5	2	1	2										2		

Type	Code	Basic Electrical Engineering	L-T-P	Credits	Marks
ES	18ES1T02			2-0-0	2

<b>Objectives</b>	The objective of this course is to introduce the students to basic concepts of electricity and magnetism. The course will cover the basics of DC & AC networks, principle of operation of different electrical machines and measuring instruments. The course will train the students about the basic protection system and safety requirements and will give an overview of the electrical power systems.
<b>Pre-Requisites</b>	Basic knowledge of intermediate Physics, knowledge of basic Mathematics such as Calculus, Ordinary Differential Equations, Matrices etc.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Fundamentals of Electric Circuits: Charge & current, Voltage & current sources, Electrical circuit elements (R, L and C) and their characteristics, Kirchoff's current and voltage laws. Resistive Network Analysis: Node voltage & Mesh current analysis, Node voltage and mesh current analysis with controlled sources, Thevenin theorem, Norton's theorem, Principle of superposition, Maximum power transfer theorem. Transient Analysis: Writing differential equations for circuits, Time-domain analysis of first-order RL and RC circuits.	<b>8 Hours</b>
<b>Module-2</b>	Representation of sinusoidal wave forms, Peak and RMS values, Phasor representation, Real, Reactive, and Apparent power, Power factor. Analysis of single-phase AC circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). Three phase balanced circuits, Voltage and current relations in star and delta connections.	<b>6 Hours</b>
<b>Module-3</b>	Electricity and magnetism, Magnetic circuit and magnetic reluctance, Magnetic materials, BH characteristics, Ideal and practical transformer, EMF equation of transformer, Equivalent circuit.	<b>4 Hours</b>
<b>Module-4</b>	Construction of DC machines, Generator, Types of excitation system, Working of DC motor, Classification of DC motor, Characteristics and speed control of DC motor. Generation of rotating magnetic fields, Construction and working of a 3-phase induction motor, Torque-slip characteristic. Single-phase induction motor.	<b>4 Hours</b>
<b>Module-5</b>	Introduction to Measuring instruments: Different electrical measuring instruments, Energy meters: Connection and elementary calculations for energy consumption. Brief introduction to generation, transmission and distribution of electrical power, Earthing & electrical safety.	<b>3 Hours</b>
<b>Total</b>		<b>28 Hours</b>

**Text Books:**

- T1. E. Hughes, *Electrical & Electronic Technology*, 9<sup>th</sup> Edition, Pearson, 2004.
- T2. G. Rizzoni, *Principles and Applications of Electrical Engineering*, 5<sup>th</sup> Edition, McGraw Hill, 2006.

**Reference Books:**

- R1. A. E. Fitzgerald, D. E. Higginbotham, and A. Grabel, *Basic Electrical Engineering*, 5<sup>th</sup> Edition, Tata McGraw Hill.
- R2. B. L. Theraja and A. K. Theraja, *Textbook of Electrical Technology (Vol-I)*, 23<sup>rd</sup> Edition, S. Chand & Co.Ltd., 2002.
- R3. L. S. Bobrow, *Foundations of Electrical Engineering*, Asian Edition, Oxford Univ. Press, 2013.

**Online Resources:**

1. <https://www.slideshare.net/billylui/lecture-1-fundamental-of-electricity>
2. [https://www.tutorialspoint.com/gate\\_syllabus/gate\\_electrical](https://www.tutorialspoint.com/gate_syllabus/gate_electrical)
3. [https://www.tutorialspoint.com/theory\\_of\\_machines](https://www.tutorialspoint.com/theory_of_machines)
4. <https://www.smartworld.com/notes/electrical-measurements-em>
5. <https://lecturenotes.in/subject/113/electrical-power-transmission>
6. <https://nptel.ac.in/courses/108108076/>
7. <https://www.electrical4u.com/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand and analyze basic electrical network with DC source.
CO2	Measure current, voltage and power of series RLC circuit excited by single-phase AC circuit.
CO3	Develop understanding of different concepts of magnetic fields and apply it to single phase transformer.
CO4	Study the working principles of rotating electrical machines.
CO5	Become familiar with the components of low-voltage electrical installations and different measuring instruments.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2									3	1	
CO2	3	3	2	3									3	1	
CO3	3	2	1	1				2					3		
CO4	3	2	2										3		
CO5	3	3	2	1									3	1	

Type	Code	Computer Programming	L-T-P	Credits	Marks
ES	18ES1T03		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to introduce fundamentals of computer programming using the C programming language to the students. Starting with simple programs, the course will cover advanced topics like structures, pointers, file processing and pre-processor directives etc. and enable the students to write programs using C language for solving various engineering problems.
<b>Pre-Requisites</b>	Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course. Prior experience with any other programming language will be beneficial.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction to computers and programming, operating system, compilers, interpreters, algorithm, flowchart, pseudocode etc., structure of C program, character set, identifier, keywords, constants, variables, data types, operators, expressions, statements, operator precedence and associativity, type conversion, input/output statements.	<b>8 Hours</b>
<b>Module-2</b>	Decision making and branching: if, if-else, nested if-else, else-if ladder and switch constructs, iterative execution of code using loops: while, for, do-while, nested loops, controlling loop behavior using jump statements (break, continue, goto) and exit statements.	<b>8 Hours</b>
<b>Module-3</b>	Arrays (1-D & 2-D), declaration and initialization of arrays, accessing array elements, operations on arrays - insertion, deletion, searching, sorting (selection sort), merging etc., character arrays and strings, initialization, input & output of strings, operations on strings, array of strings, string handling functions.	<b>9 Hours</b>
<b>Module-4</b>	User-defined functions, declaration and definition, parameter passing by value, functions returning values, idea on call by reference, passing arrays to functions, recursion, storage classes - auto, register, static, extern, Structures and Unions - definition, initialization, accessing members, array of structures, arrays within structures, structures and functions, self-referential structures.	<b>9 Hours</b>
<b>Module-5</b>	Understanding pointers, declaration, initialization, accessing variables using pointers, pointer expressions, scale factor, chain of pointers, using pointers with arrays, strings, functions and structures, dynamic memory management, pre-processor directives, command line arguments, basics of file handling.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>



**Text Books:**

- T1. E. Balagurusamy, *Programming in ANSI C*, 7<sup>th</sup> Edition, McGraw-Hill Education, 2017.  
 T2. Y. Kanetker, *Let Us C*, 16<sup>th</sup> Edition, BPB Publications, 2018.

**Reference Books:**

- R1. B. W. Kernighan and D. M. Ritchie, *The C Programming Language*, 2<sup>nd</sup> Edition, Pearson Education, 2015.  
 R2. H. Schildt, *C: The Complete Reference*, 4<sup>th</sup> Edition, McGraw-Hill, 2017.  
 R3. A. Kelley and I. Pohl, *A Book on C*, 4<sup>th</sup> Edition, Pearson Education, 2008.  
 R4. B. Gottfried, *Schaum's Outline of Programming with C*, 3<sup>rd</sup> Edition, McGraw-Hill, 2017.

**Online Resources:**

1. <http://www.stat.cmu.edu/~hseltman/c/CTips.html>
2. <http://www.c-faq.com/>
3. <https://www.learn-c.org/>
4. <https://www.javatpoint.com/c-programming-language-tutorial>
5. <http://www2.its.strath.ac.uk/courses/c/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Formulate logic of a problem and write C programs using variables, expressions and input/output statements.
CO2	Develop structured C programs involving decision making using different control constructs.
CO3	Solve problems involving similar set of data items and convert them into C programs using arrays.
CO4	Design modular C programs and handle heterogeneous data items using structures & unions.
CO5	Write C applications using pointers, pre-processor directives, command line arguments and files.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1								1	3		2
CO2	3	3	2	2								1	3		2
CO3	3	3	2	2								1	3		2
CO4	3	2	2	2								1	3		2
CO5	3	3	2	3								1	2		2

Type	Code	Communicative & Technical English	L-T-P	Credits	Marks
HS	18HS1T01		3-0-0	3	100

<b>Objectives</b>	The objectives of this course are to develop the students' communication skills with proficiency in Technical English, to make them aware of the importance of cross-cultural communication, to develop analytical skills to read and comprehend texts, and to help compose effective business messages.
<b>Pre-Requisites</b>	Basic knowledge of English grammar and the ability to read and write using the English language.
<b>Teaching Scheme</b>	Regular classroom lectures with the use of PPTs as and when required; sessions are planned to be interactive with focus on improving spoken and written communication skills in English.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Elements of Technical Communication:</b> General vs Technical Communication; Factors, participants, code, channels, message, feedback, Effective Business Communication; Importance of technical communication; Communication across cultures and common problems; Barriers to effective communication.	<b>6 Hours</b>
<b>Module-2</b>	<b>Sounds of English:</b> vowels, diphthongs, consonants and consonant clusters, problem sounds, phonemic transcription, syllabic division and stress, weak forms and rhythm, intonation.	<b>5 Hours</b>
<b>Module-3</b>	<b>Effective Business Communication:</b> Structure of a business organization; purpose of business organization; Technology in communication; use of bias-free language; channels of communication: upward, downward, diagonal, grapevine, open door communication; forms of technical communication: internal, external, formal, informal, oral, written. Language structures for day-to-day business communication: persuasion, negotiation, argumentation, making suggestions, assertive communication. Public speaking and presentation skills; content development; clarity of speech; emotions displayed by body language, personal space and zones, personal appearance and attitude to time.	<b>9 Hours</b>
<b>Module-4</b>	<b>Critical Reading:</b> sub-skills of reading; reading a feature article; reading an editorial; skimming through a short report; reading contemporary essays; reading prescribed English short stories.	<b>11 Hours</b>
<b>Module-5</b>	<b>Effective Business Writing:</b> constituents of effective writing: ; paragraph development: coherence, cohesion, progression of ideas, elements of style, clarity and precision, avoiding redundancy, circumlocution, jargons; Dealing with positive and negative messages; business writing: writing a memo; writing an e-mail, writing business letters, notice, writing different types of reports, writing a proposal.	<b>11 Hours</b>
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. M. A. Rizvi, *Effective Technical Communication*, McGraw Hill.
- T2. T. Balasubramaniam, *English Phonetics for Indian Student*, Trinity Press.
- T3. B. K. Das, *An Introduction to Professional English and Soft Skills*, Cambridge Univ. Press, 2009.
- T4. D. K. Das, A. Kumari, K. K. Padhi, *Anthology of Modern English Prose*, Trinity Press.

**Reference Books:**

- R1. S. Samantray, *Business Communication and Communicative English*, S. Chand & Co.
- R2. J. Seeley, *The Oxford Guide to Writing and Speaking*, Oxford Univ. Press.
- R3. B. K. Mitra, *Communication Skills for Engineers*, Oxford Univ. Press, 2011.
- R4. M. Raman, S. Sharma, *Technical Communication: Principles & Practice*, Oxford Univ. Press.

**Online Resources:**

1. <http://www.cambridgeindia.org>
2. <http://www.cambridgeenglish.org/exams/business-certificates/business>
3. <https://steptest.in>
4. <https://www.coursera.org/specializations/business-english>
5. <http://www.academiccourses.com/Courses/English/Business-English>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand the elements of technical communication and communication across cultures.
CO2	Learn about aspects of English pronunciation and speak using a neutral accent.
CO3	Learn about the channels of business communication and business hierarchies in order to communicate effectively in a business set up.
CO4	Enhance their reading skills and be able to critically analyse texts of various kind.
CO5	Compose different types of business correspondences effectively.

**Program Outcomes Relevant to the Course:**

PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1								1	2	3	2	3		3	3
CO2									1	3	1	3		3	1
CO3								1	3	3	2	3		3	2
CO4										3		3		1	2
CO5								2	1	3	1	3		3	2

Type	Code	Constitution of India	L-T-P	Credits	Marks
MC	18NC1T01			2-0-0	0

<b>Objectives</b>	The objective of this subject is to provide understanding of the basic concepts of Indian Constitution and various organs created by the constitution including their functions. The course acquaints students with the constitutional design of state structures and institutions, and their actual working over time.
<b>Pre-Requisites</b>	Basic knowledge of Indian history, overall idea on India's political system.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required and each session is planned to be interactive.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction to Indian Constitution, Historical perspective of the constitution of India. Preamble of Indian constitution, Salient features of Indian constitution, Fundamental rights, Fundamental Duties and its legal status, Directive principles of state policy-its importance and Implementation.	<b>8 Hours</b>
<b>Module-2</b>	Federal structure and distribution of legislative and financial powers between the Union and the States, The Union legislature - The Parliament - The Lok Sabha and the Rajya Sabha, Composition, powers and functions, Union executive, President of India (with powers and functions), Vice-President, The Council of Ministers and the Prime Minister - Powers and functions.	<b>6 Hours</b>
<b>Module-3</b>	State Government, The State Legislature - composition, powers and functions, State executive, Governor (with powers and functions).	<b>5 Hours</b>
<b>Module-4</b>	Amendment of the Constitutional Powers and Procedure, Emergency Provisions : National Emergency, President Rule, Financial Emergency. Scheme of the Fundamental Right to Equality Scheme of the Fundamental Right to certain Freedom under Article 19, Scope of the Right to Life and Personal Liberty under Article 21. Local Self Government - Constitutional Scheme in India.	<b>5 Hours</b>
<b>Module-5</b>	The Indian Judicial System - the Supreme Court and the High Court's composition, jurisdiction and functions, Judicial review, Judicial activism, independence of Judiciary in India.	<b>4 Hours</b>
<b>Total</b>		<b>28 Hours</b>

#### Text Books:

- T1. D. D. Basu, *Introduction of Constitution of India*, 22<sup>nd</sup> Edition, LexisNexis, 2015.
- T2. K. Subas, *An Introduction to India's Constitution and Constitutional Law*, 5<sup>th</sup> Edition, National Book Trust India, 2011.

**Reference Books:**

- R1. M. Laxmikanth, *Indian Polity*, 5<sup>th</sup> Edition, McGraw Hill, 2011.  
 R2. P. M. Bakshi, *The Constitution of India*, 14<sup>th</sup> Edition, Universal Law Publishing Co, 2006.

**Online Resources:**

1. [https://www.india.gov.in/sites/upload\\_files/npi/files/coi\\_part\\_full.pdf](https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf)
2. <https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text>
3. [https://www.tutorialspoint.com/indian\\_polity/indian\\_polity\\_tutorial.pdf](https://www.tutorialspoint.com/indian_polity/indian_polity_tutorial.pdf)
4. <https://www.careerpower.in/wp-content/uploads/2016/03/SSC-POLITY-CIVICS-CAPSULE-2016.pdf>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Provide basic information about Indian constitution and to analyze the legalities and related issues of drafting, adoption and enforcement of the Indian Constitution as a fundamental law of the nation and the provisions and privileges of Indian Citizenship.
CO2	Understand and judiciously use the fundamental rights and privileges envisaged in the constitution propagating social harmony and equality and respecting the rights and liberties of other people.
CO3	Analyze the major dimensions of Indian Political System and to contribute in protecting and preserving the sovereignty and integrity of India.
CO4	Know the successful functioning of democracy in India and to respect the Constitutional Institutions like Judiciary, Executive and Legislature.
CO5	Understand their obligations, responsibilities, privileges & rights, duties and the role that they have to play in deciding the Administrative Machinery of the country.

**Program Outcomes Relevant to the Course:**

PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1				1		2	1	1	1					1	2
CO2						2	1	1	1					1	2
CO3						3	1	1	1					1	1
CO4						2	1	1	1					1	2
CO5						2	1	2	1					1	2

Type	Code	Environmental Science & Engineering	L-T-P	Credits	Marks
MC	18NC1T02			2-0-0	0

<b>Objectives</b>	This course serves as a general introduction to environmental science. From ecology and ecosystems, it acquaints the students to air & water quality and the impact of pollution on the environment due to industries and urbanization. Some remediation methods of minimizing the impact of pollutants through technology and legal systems are also addressed.
<b>Pre-Requisites</b>	Basic knowledge of physics, chemistry and biology is required for this course.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required and some sessions are planned for expert talk, seminar presentation by students.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Ecology & Biogeochemical Cycles: Introduction to environmental science, ecological perspective and value of environment, biodiversity of species, biotic components, energy, food chain, biogeochemical cycles like water, oxygen, nitrogen and carbon cycle.	<b>5 Hours</b>
<b>Module-2</b>	Environmental gradients & Laws: Environmental gradients, tolerance levels of environment factors, Indian environmental laws and activities including seminar presentations by students.	<b>4 Hours</b>
<b>Module-3</b>	Water & Wastewater Treatment: Water quality standards and parameters, pre-treatment and conventional treatment processes of water, DO, BOD, COD, wastewater treatment.	<b>4 Hours</b>
<b>Module-4</b>	Atmospheric chemistry, soil chemistry, ground water recharge, noise source & abatement: atmospheric chemistry, air pollution, climate change, soil chemistry, water table and aquifer, ground water recharge, noise standards, noise measurement, noise control and activities including expert talk.	<b>5 Hours</b>
<b>Module-5</b>	Solid Waste & Hazardous Waste Management: Source, classification and composition of MSW, MSW management, 3R principles, hazardous waste generation and their management, environment impact assessment, origin & procedure of EIA, project screening for EIA, scope studies, preparation and review of EIS.	<b>5 Hours</b>
<b>Module-6</b>	Environment and Human Health: Environment and human health, the impact of the IT industry on the environment including e-waste, activities including presentation & report submission on environmental problems.	<b>5 Hours</b>
<b>Total</b>		<b>28 Hours</b>

#### Text Books:

- T1. G. M. Masters and W. P. Ela, *An Introduction to Environmental Engineering and Science*, PHI.
- T2. G. Kiely, *Environmental Engineering*, Intl. Edition, McGraw Hill.

**Reference Books:**

- R1. M. L. Davis and S. J. Masten, *Principles of Environmental Engineering and Science*, Intl. Edition, McGraw-Hill.  
 R2. H. D. Kumar and U. N. Dash, *Environmental Studies*, IndiaTech Publishers.

**Online Resources:**

1. <http://nptel.ac.in/courses/120108002/>: Aquatic Biodiversity and Environmental Pollution.
2. <http://nptel.ac.in/courses/120108004/>: Environment Management.
3. <http://nptel.ac.in/courses/120108005/>: Municipal Solid Waste Management.
4. <https://www.epa.gov/environmental-topics/>: All Current Environmental Issues.

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Apply concepts of ecology, eco systems, food chain and biogeochemical cycles for better understanding of functions of the environment.
CO2	Understand environmental gradients, tolerance levels and environmental laws for prevention of environmental pollution.
CO3	Enhance knowledge of water and wastewater treatment for prevention of water pollution.
CO4	Understand the chemistry of pollutants in the atmosphere, soil and groundwater and understand principles of noise abatement.
CO5	Enhance knowledge of waste minimization technique to minimize and manage solid, hazardous wastes generated in different areas.
CO6	Understand the role of IT and human health, and the issues of e-waste management.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1					2	3	1	2		1			2	1
CO2	1					3	3	3	2		1			2	2
CO3	1					2	2	2	2		1			2	2
CO4	1					1	2	1	1		1			2	2
CO5	1					2	3	1	2		1			2	2
CO6	1					3	3	3	2		1			3	3



Type	Code	Engineering Mathematics - II	L-T-P	Credits	Marks
BS	18BS1T02		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to familiarize the perspective engineers with the knowledge and concepts of probability and statistics which are essential to study non-deterministic systems.
<b>Pre-Requisites</b>	Basics of sets, counting techniques, differential and integral calculus of one variable and coordinate geometry of two and three dimensions.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Laplace transform, Inverse Laplace transform, shifting theorems, Transform of derivatives and integrals, Unit step function and Dirac delta function, applications to differential equations.	<b>7 Hours</b>
<b>Module-2</b>	Differentiation & Integration of Transforms, Convolution and integral equations, Use of partial fraction, system of differential equations.	<b>7 Hours</b>
<b>Module-3</b>	Random Experiment & Probability, Conditional Probability, Bayes' Rule, Random variable & Probability Distribution, Mean, Variance.	<b>8 Hours</b>
<b>Module-4</b>	Uniform Discrete Distributions: Binomial, Poisson, Hyper geometric, Geometric Random Variable, Continuous Uniform Distribution: Normal Distribution, Exponential Distribution.	<b>8 Hours</b>
<b>Module-5</b>	Joint Distribution, Covariance, Sampling & sampling distributions, maximum likelihood estimation, Estimation of mean, Confidence Interval of mean, difference of two means, variance.	<b>7 Hours</b>
<b>Module-6</b>	Testing of Hypothesis about mean, two means and variance, Testing goodness of fit, Linear regression, least square line, correlation coefficient.	<b>5 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

T1. E. Kreyszig, *Advanced Engineering Mathematics*, 8<sup>th</sup> Edition, Wiley India, 2015.

#### Reference Books:

R1. S. Pal and S. C. Bhunia, *Engineering Mathematics*, 1<sup>st</sup> Edition, Oxford University Press, 2015.  
 R2. B. V. Ramana, *Higher Engineering Mathematics*, 1<sup>st</sup> Edition, MC Graw Hill, 2017.

#### Online Resources:

1. <http://www.nptel.ac.in/courses/111105035/32>
2. <http://www.nptel.ac.in/courses/122104017>
3. <http://nptel.ac.in/courses/122102009>
4. [www.edx.org/Probability](http://www.edx.org/Probability)
5. <https://ocw.mit.edu/courses/.../18-440-probability-and-random-variables-spring-2014/>

6. <https://ocw.mit.edu/courses/mathematics/18-03sc-differential-equations-fall-2011/unit-iii-fourier-series-and-laplace-transform/laplace-transform-basics/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Study and use the concepts of probability and random variables and applying them to evaluate probabilities of different events.
CO2	Know different discrete and Continuous probability models and apply those to solve probability problems of day to day activities.
CO3	Understand the applications of joint & sampling distributions.
CO4	Learn methodology to apply statistical testing and regression.
CO5	Study the concepts of Laplace Transform and to apply those for solving ODE.
CO6	Develop understanding of convolution and its application to integral equations.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2								3	1	1
CO2	3	3	3	3	3								3	1	1
CO3	3	2	3	2	2								2	1	1
CO4	3	3	3	3	2								2	1	1
CO5	3	3	2	2	3								2	1	1
CO6	3	3	2	2	3								2	1	1

Type	Code	Data Structures & Algorithms	L-T-P	Credits	Marks
ES	18ES1T05		3-0-0	3	100

<b>Objectives</b>	To understand the abstract data types and to solve problems using data structures such as stacks, queues, linked lists, hash tables, binary trees, heaps, binary search trees, graphs and writing programs for these solutions.
<b>Pre-Requisites</b>	Knowledge of programming in C, specifically on structures, pointers, functions, recursion etc., are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction to data structures, classification of data structures, algorithmic notation, complexity of algorithms, asymptotic notations, abstract data types. Arrays - introduction, representation of arrays (row and column major representation), basic operations on array (traverse, insert, delete, search), sparse matrix, representation of sparse matrix using triplet form, operations on sparse matrix (addition, transpose)	<b>8 Hours</b>
<b>Module-2</b>	ADT Stack - stack model, representation of stack using array, basic operations with analysis, applications- recursion, and conversion of infix to post fix expression, evaluation of postfix expression. ADT Queue - queue model, representation using array, basic operations with analysis, circular queue, introduction to priority queue and double ended queue.	<b>8 Hours</b>
<b>Module-3</b>	Linked list - introduction, types of linked list (single, double, circular), representation in memory, operations on linked list (traverse, search, insert, delete, sort, merge) in each type with analysis. Representation of polynomial and its operations (addition, multiplication), implementation of stack and queue using linked list.	<b>9 Hours</b>
<b>Module-4</b>	Tree - terminology, representation, binary tree - tree traversal algorithms with and without recursion. Binary search tree, Operations on Binary Search Tree with analysis, threaded binary tree, general tree, Height balanced tree (AVL tree), m-way search trees, B-trees. Graph - terminology, representation (adjacency matrix, incidence matrix, path matrix, linked representation), graph traversal (BFS, DFS), Dijkstra's single source shortest path algorithm, Warshall's all pair shortest path algorithm, topological sort.	<b>9 Hours</b>
<b>Module-5</b>	Sorting algorithms - bubble sort, selection sort, insertion sort, quick sort, merge sort, radix sort, heap sort. Hashing- hash functions and hashing techniques. collision resolution techniques- linear probing, quadratic probing, chaining.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. E. Horowitz, S. Sahni, S. Anderson-Freed, *Fundamentals of Data Structures in C*, 2<sup>nd</sup> Edition, Universities Press, 2008.
- T2. M. A. Weiss, *Data Structures and Algorithm Analysis in C*, 2<sup>nd</sup> Edition, Pearson Education, 2002.

**Reference Books:**

- R1. A. M. Tenenbaum, Y. Langsam, and M. J. Augenstein, *Data Structures Using C*, 3<sup>rd</sup> Edition, Pearson Education, 2007.
- R2. J. P. Tremblay and P. G. Sorenson, *An Introduction to Data Structures with Applications*, 2<sup>nd</sup> Edition, McGraw Education, 2017.
- R3. S. Lipschutz, *Data Structures*, 1<sup>st</sup> Revised Edition, McGraw Education, 2014.

**Online Resources:**

1. <http://nptel.ac.in/courses/106102064/1>
2. <http://www.nptelvideos.in/2012/11/programming-and-data-structure.html>
3. [https://www.tutorialspoint.com/data\\_structures\\_algorithms/index.htm](https://www.tutorialspoint.com/data_structures_algorithms/index.htm)
4. <https://www.coursera.org/learn/data-structures/>
5. <https://www.geeksforgeeks.org/data-structures/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Analyze performance of algorithms and implement various operations on array and sparse matrix.
CO2	Apply the basic operations of stacks and queues to solve real world problems.
CO3	Implement different types of linked list operations and their applications.
CO4	Represent data using trees & graphs to use them in various real life applications.
CO5	Analyze various sorting algorithms and explore different hashing techniques.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2		1						1	3		3
CO2	3	3	3	2		1						1	3		3
CO3	3	3	3	2		1						1	3		3
CO4	3	2	3	3		2						1	3		3
CO5	3	3	3	3		1						1	3		3

Type	Code	Engineering Chemistry Lab	L-T-P	Credits	Marks
BS	18BS1L05		0-0-2	1	100

<b>Objectives</b>	Objectives of the subject is to educate the students with modern instrumental techniques & role of chemical analysis in various fields of engineering and science to examine and understand the effect of chemicals, compositions, impurities etc., on the properties of materials & the detrimental effects of polluting materials, and other unwanted impurities.
<b>Pre-Requisites</b>	Student should have the knowledge of balancing equations, principle of titrations, titrant, titrand, preparation of standard solutions, concentration of a solution, indicators used in a titration, principle of reduction-oxidation reactions, handling of instruments like pH meter & accurate measurement of sample by using electronic balance.
<b>Teaching Scheme</b>	Regular laboratory experiments conducted under supervision of the teacher. Demonstration will be given for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Determination of Total hardness of water sample by EDTA method.
2	Determination of alkalinity of water.
3	Determination of available chlorine of bleaching powder/residual chlorine in tap water.
4	Determination of dissolved oxygen in supplied water.
5	Determination of saponification value of oil.
6	Determination of Acid value of oil.
7	Determination of Flash-point/fire point of a lubricant by Pensky-Martens apparatus.
8	Determination of kinematic viscosity and Viscosity Index of a lubricant by Redwood viscometer.
9	Determination of concentration of a colour substance by Spectrophotometer.
10	Green synthesis of noble metal/oxide based nanoparticles.
11	Estimation of calcium in limestone powder.
12	Determination of chloride content of water.
13	Determination of the partition coefficient of a substance between two immiscible liquids.
14	Adsorption of acetic acid by charcoal.
15	Use of the capillary viscosimeters to demonstrate the isoelectric point as the pH of minimum viscosity for gelatin solutions and/or coagulation of the white part of egg.
16	Proximate analysis of coal sample.
17	Determination of iodine value of oil/fat.

**Text Books:**

- T1. Jain & Jain, *Engineering Chemistry*, 16<sup>th</sup> Edition, Dhanpat Rai Publishing Company, 2015.  
 T2. S. S. Dara, *Engineering Chemistry*, 12<sup>th</sup> Edition, S. Chand Publisher, 2014.

**Reference Books:**

- R1. S. Chawla, *Essentials of Experimental Engineering Chemistry*, Dhanpat Rai & Co.  
 R2. S. K. Bhasin and S. Rani, *Laboratory Manual on Engineering Chemistry*, 3<sup>rd</sup> Edition, Dhanpat Rai & Co, 2012.

**Online Resources:**

1. <https://www.metrohm.com/en/industries/petro-lubricants/>: Lubricant analysis according to international standards
2. <http://www.eco-web.com/edi/01759.html>: Efficient Wastewater Treatment: The field for analytical and monitoring

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Analyse various water quality parameters such as alkalinity, hardness, dissolved oxygen & chloride content before it is put into use in various general, research, or industrial purposes.
CO2	Test the quality of an oil/fat by measuring its iodine or acid value by means of amount of unsaturation for various industrial use.
CO3	Verify quality of a lubricant by means of its viscosity or flash point which gives their nature & flammability for various industrial applications.
CO4	Analyse various fractions present in coal by proximate analysis for better use of carbon based compounds in industrial applications.
CO5	Study the importance of green synthesis by way of synthesising metal/ metal oxide based nano-particles for various material applications.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

*Cont'd...*

PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
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**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		1	2		1		2	1			2	1	1
CO2	2	2		1	2		2		2	2			1	1	1
CO3	3	2		1	2		1		2	2			1	1	1
CO4	3	3		1	1		2		2	2			2	1	1
CO5	3	2		1	1		1		1	1			2	1	1



Type	Code	Engineering Physics Lab	L-T-P	Credits	Marks
BS	18BS1L02			0-0-2	1

<b>Objectives</b>	The objective of this course is to develop the basic practical skill to design and measure different parameters of a physical quantity with proper error analysis which can help them in different field of engineering sciences. This practical knowledge will be useful for the engineering students to understand the basic operating principle of instruments. The knowledge obtained can also be used to prepare various models and projects.
<b>Pre-Requisites</b>	Adequate practical knowledge in Higher Secondary Physics including measuring instruments like screw gauge, slide caliper, spherometer etc. Knowledge of error analysis, graphical analysis etc. is also required.
<b>Teaching Scheme</b>	Regular laboratory experiments conducted under supervision of the teacher. Demonstration will be given for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Determination of bandgap of semiconductor.
2	Determination of rigidity modulus by static method.
3	Determination of surface tension by capillary rise method.
4	Determination of acceleration due to gravity by bar / Kater's pendulum.
5	Determination of Plank's constant, verification of inverse square law by photocell.
6	Determination of wavelength of light by Newton's ring apparatus.
7	Determination of grating element of a diffraction grating.
8	Plotting of characteristic curve of a PN junction diode.
9	Plotting of characteristic curves of BJT.
10	Verification of laws of vibration of stretched string using sonometer.
11	Determination of wavelength of laser source by diffraction grating method.
12	Study of Hall effect.
13	Study of RC circuit.
14	Determination of Young's modulus by bending of beams.
15	Michelson Interferometer.
16	Determine of reduction factor of the given tangent galvanometer and horizontal component of Earth's magnetic field using tangent galvanometer.

#### Text Books:

- T1. C. L. Arora, *B.Sc. Practical Physics*, 20<sup>th</sup> Edition, S.Chand & Co.Ltd, 2009.  
 T2. S. Srivastava, *Practical Physics*, 3<sup>rd</sup> Edition, New Age International, 2017.

#### Reference Books:

- R1. H. Singh, *B.Sc. Practical Physics*, S. Chand & Co.Ltd, 2002.

R2. B.Mallick, S. Panigrahi, *Engineering Practical Physics*, Cengage Learning, 2015.

#### Online Resources:

1. <https://nptel.ac.in/courses/122103010/>
2. <https://www.practicalphysics.org/>
3. <http://www.bsauniv.ac.in/>: Search for PHYSICS-LAB-MANUAL2017-(new-regulation).pdf
4. <https://arxiv.org/ftp/arxiv/papers/1510/1510.00032.pdf>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Analyze the wave aspect of light like interference and diffraction by conducting Newton's rings and Fraunhofer diffraction experiment.
CO2	Investigate some properties of matter like surface tension of water (capillary rise method) and coefficient of elasticity of steel, copper.
CO3	Verify and analyze the IV characteristics of junction diode and BJT, charging and discharging of capacitor in RC circuit.
CO4	Study and apply Hall effect to calculate the Hall coefficient, carrier concentrations; measure band gap of semiconductor and dielectric constant of dielectric material.
CO5	Understand and verify laws of transverse vibrations in a stretched string using sonometer.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		2								1	3	1	1
CO2	2	2		1	1							1	2		1
CO3	2	1		2									2	1	1
CO4	2	2		3	1								3		1
CO5	3	1		1								1	2		1

Type	Code	Manufacturing Practices	L-T-P	Credits	Marks
ES	18ES1L04			0-0-2	1

<b>Objectives</b>	The objective of this practical course is to provide the basic concepts about tools used in manufacturing practices. Detailed concepts are proposed in all the major trades of engineering interest.
<b>Pre-Requisites</b>	None
<b>Teaching Scheme</b>	Regular manufacturing jobs using tools under supervision of the teacher. Demonstration will be given for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction of fitting practice and tools used in fitting jobs.
2	Exercise involving measuring, marking, cutting and filing practice.
3	Fitting of male and female mating parts.
4	Introduction of Lathe, exercise involving facing, straight turning, step turning, taper turning and thread cutting in Lathe machine.
5	Introduction of Milling and Shaping machines.
6	Preparing single step on a square block in Milling machine.
7	Preparing a key way on a square block in Shaping machine.
8	Introduction to basic principles of Arc and Gas welding.
9	Preparing lap joint by Gas welding and butt joint by Arc welding.
10	Sheet metal forming and joining operations.

#### Text Books:

- T1. P. Kannaiah and K. L. Narayana, *Workshop Manual*, Sceitech Publishers, 2009.
- T2. S. K. Hajra Choudhury, *Elements of Workshop Technology*, Vol-1 and Vol-2, MPP..

**Reference Books:** *There are no reference books for this subject.*

#### Online Resources:

1. <http://www.technicaltrainingsolutions.co.uk/courses/bench-fitting-course.html>
2. <http://nptel.ac.in/courses/112101005/14> (Sheet Metal Forming Processes)
3. <http://nptel.ac.in/downloads/112105127> (Machining Processes)
4. <http://nptel.ac.in/courses/112107144/27> (Welding Processes)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Study and practice use of hand tools and their operations in a fitting shop.
CO2	Design and model various basic prototypes in fitting, such as a Paper weight.
CO3	Design and model and use of various suitable tools form a chining processes like facing, straight turning, step turning, taper turning and thread cutting.

*Cont'd...*

CO4	Identify and use suitable tools for cutting of a mild steel work piece with the help of shaping and milling machines.
CO5	Design and model various basic prototypes in welding such as a Lap joint and Butt joint.
CO6	Design and model various basic prototypes using sheet metal forming and joining operations.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1		1			1			3		3	2		1	2
CO2	1		2			1			3		3	2		1	2
CO3	1		2			1			3		3	2			2
CO4	1		2			1			3		3	2		1	2
CO5	1		2			1			3		3	2		1	2
CO6	1		2			1			3		3	2		1	2

Type	Code	Engineering Graphics Lab	L-T-P	Credits	Marks
ES	18ES1L05			0-0-2	1

<b>Objectives</b>	To create awareness and emphasize the need for Engineering Graphics in all the branches of engineering, to follow basic drawing standards and conventions, to develop skills in three-dimensional visualization of engineering component, to solve specific geometrical problems in plane geometry involving lines, plane figures and special curves, to produce orthographic projection of engineering components working from pictorial drawings.
<b>Pre-Requisites</b>	Basic understanding of Geometry
<b>Teaching Scheme</b>	Regular laboratory classes using drawing tools under supervision of the teacher. Demonstration will be given for each drawing assignment using ICT as when required.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Principles of Engineering Graphics and their significance, usage of various drawing instruments, lettering, dimensioning principles.
2	Conics and Engineering Curves.
3	Orthographic Projections: Principles of orthographic projections - conventions, projections of points and lines.
4	Auxiliary projection Technique: Projection of Points and lines on Auxiliary Planes.
5	Projections of Planes: projections of planes in simple position & inclined to both planes.
6	Projection of Solids: projection of solids in simple position & inclined to both planes.
7	Principles of Isometric projection, isometric scale, isometric views, conventions, isometric views of lines & planes.
8	Isometric projections of solids, conversion of isometric views to orthographic views.
9	Development of surface and intersection of surfaces.
10	Sections and sectional views of simple and compound solids.
11	Introduction to AUTOCAD tools.

### Text Books:

- T1. N. D. Bhat, M. Panchal, *Engineering Drawing*, Charotar Publishing House, 2008.
- T2. M. B. Shah, B. C. Rana, *Engineering Drawing and Computer Graphics*, Pearson Education, 2008.
- T3. R. K. Dhawan, *A Text Book of Engineering Drawing*, S. Chand Publications, 2007.
- T4. K. L. Narayana, P. Kannaiah, *Text Book on Engineering Drawing*, Scitech Publishers, 2008.

**Reference Books:**

- R1. T. E. French, C. J. Vierck, R. J. Foster, *Graphic Science and Design*, 4<sup>th</sup> Edition, McGraw-Hill.
- R2. W. J. Luzadder, J. M. Duff, *Fundamentals of Engineering Drawing*, 11<sup>th</sup> Edition, PHI, 1995.
- R3. K. Venugopal, *Engineering Drawing and Graphics*, 3<sup>rd</sup> Edition, New Age International, 1998.

**Online Resources:**

1. <http://nptel.ac.in/courses/112103019>
2. <https://freevideolectures.com/course/3420/engineering-drawing>
3. <http://www.engineeringdrawing.org/>
4. [https://ocw.mit.edu/courses/mechanical-engineering/2-007-design-and-manufacturing-i-spring-2009/related-resources/drawing\\_and\\_sketching/](https://ocw.mit.edu/courses/mechanical-engineering/2-007-design-and-manufacturing-i-spring-2009/related-resources/drawing_and_sketching/)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand and apply the concepts of lettering and dimensioning for drafting of machine drawings and building drawings and different Conics and Engineering Curves.
CO2	Recognize and be familiar with the Orthographic projections of points, lines.
CO3	Develop the concept of Orthographic projections of planes and solids.
CO4	Differentiate between isometric scale, isometric projections and views.
CO5	Have a broad overview of various sheet-metal work by the concept of development of surfaces and solids and Sectional Views of Simple and compound solids.
CO6	Draw various machine components and building structure drawing by using AutoCAD.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	1					2	1	1	1	1	1
CO2	3	2	1	1	1					2	1	1	1		1
CO3	3	2	1	1	1					2	1	1	1		1
CO4	3	1	1	1	1					2	1	1	1		1
CO5	3	2	2	2	3					2	2	1	1		1
CO6	3	2	1	1	2					2	2	1	1		1

Type	Code	Basic Electronics Engineering Lab	L-T-P	Credits	Marks
ES	18ES1L01			0-0-2	1

<b>Objectives</b>	Know broadly the concepts and functionalities of the electronic devices, tools and instruments. Understand general specifications and deployability of the electronic devices, and assemblies. Develop confidence in handling and usage of electronic devices, tools and instruments in engineering applications.
<b>Pre-Requisites</b>	Knowledge on intrinsic and extrinsic Semiconductors, Physics and Chemistry of Higher Secondary Science level.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted under the supervision of teachers and demonstrators with the help of ICT, as and when required along with pre-lab session and demonstration for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Familiarization of electronic components and devices (Testing of semiconductor diodes and transistors using digital multi-meter).
2	Study and use of Oscilloscope, signal generator to view waveforms and measure amplitude and frequency of a given waveform.
3	V-I characteristics of semiconductor diode and determining its DC and AC resistances.
4	Implementation of clipper circuits, both positive clipper and negative clipper. Observe its output waveforms and compare them with theoretical analyzed results.
5	Study of half-wave and full-wave rectifier circuits without and with capacitor filter; recording of the waveforms and measurement of average and rms values of the rectified output.
6	Study of static characteristics of BJT in CE configuration.
7	DC biasing (Fixed bias) of the transistor in CE configuration and determination of its operating point.
8	Studies on Op-Amp applications (Inverting, non-inverting, integrating differentiating configurations) recording of the input-output waveforms.
9	Studies on logic gates (truth table verification of various gates, implementation of EXNOR and Half Adder using basic gates).
10	Design of 2:1 MUX and simple SR Latch.

#### Text Books:

- T1. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 11<sup>th</sup> Edition, Pearson Education.
- T2. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, 7<sup>th</sup> Edition, Oxford University Press.

#### Reference Books:

- R1. V. K. Mehta and R. Mehta, *Principles of Electronics*, 3<sup>rd</sup> Edition, S. Chand Publishing, 1980.



**Online Resources:**

1. [http://vlab.co.in/ba\\_labs\\_all.php?id=1](http://vlab.co.in/ba_labs_all.php?id=1)
2. <http://iitg.vlab.co.in/?sub=59&brch=165>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Familiarize with various electronic components, measuring instruments, semiconductor diodes and their applications.
CO2	Acquire knowledge of characteristics of transistors and design, testing & implementation of transistors in various applications
CO3	Gain understanding of operational amplifiers (Op-Amp) and design & testing of electronic circuits for various applications using Op-Amp.
CO4	Develop understanding of digital logic gates and design & test digital circuits for various applications using logic gates.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1										2		
CO2	3	3	2	1									3		
CO3	2	2	2	1									2		
CO4	2	2	3										2		

Type	Code	Basic Electrical Engineering Lab	L-T-P	Credits	Marks
ES	18ES1L02			0-0-2	1

<b>Objectives</b>	Introduce the students to different electrical components and basic safety rules and regulations, give hands on practice about different measuring and protection equipment and their operations, help the students to understand and verify the basic concept of electrical & magnetic circuits and electric machines. The laboratory experiments shall go hand-in-hand with the topics taught in the theory class.
<b>Pre-Requisites</b>	Basic knowledge of different electrical components and different analysis techniques of electrical and magnetic circuits. Topics taught in Basic Electrical Engineering theory class are essential to conduct the experiments.
<b>Teaching Scheme</b>	Regular laboratory experiments conducted under supervision of the teacher. Demonstration will be given for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Connection and measurement of power consumption of a fluorescent lamp.
2	Identification of different terminals of a DC compound machine.
3	Power and power factor measurement of 3-phase load by two wattmeter method.
4	Connection and testing of a single-phase energy meter.
5	Determination of open circuit characteristics (OCC) of DC shunt generator.
6	Calculation of power and power factor in series R-L-C circuit by AVW method.
7	Polarity test of a single-phase transformer.
8	Study of single-phase induction motors / fan motor.
9	Verify Thevenin's Theorem and Superposition Theorem.
10	Draw the B-H curve of a magnetic Specimen.
11	Starting of three-phase induction motor.
12	Regulation and efficiency of single phase transformer by direct loading.

#### Text Books:

- T1. A. Husain, *Fundamentals of Electrical Engineering*, 4<sup>th</sup> Edition, Dhanpat Rai & Co., 2016.  
 T2. B. L. Thereja & A. K. Thereja, *A Textbook of Electrical Technology*, 23<sup>rd</sup> Edition, S. Chand & Co.

#### Reference Books:

- R1. J. B. Gupta, *A Textbook of Electrical Science*, S. K. Kataria & Sons, 2013.  
 R2. B. R. Gupta and V. Singhal, *Electrical Science*, S. Chand & Co, 2005.

#### Online Resources:

- www.nptel.iitm.ac.in/electricalengineering
- www.electronics-tutorials.ws/dc-circuits

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Get an exposure to common electrical components and their ratings.
CO2	Make electrical connections by wires of appropriate ratings.
CO3	Understand the usage of common electrical measuring instruments.
CO4	Understand the basic characteristics of transformers and electrical machines.
CO5	Verify different network theorems and magnetic properties.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1			2		1		1	1	1	1	1	1		1
CO2	2			2		1		2	1	1	2	1	1		1
CO3	1			3		2		2	1	1	1	1	1		1
CO4	1			2		2		1	1	2	2	1	1		1
CO5	1			1		1		1	1	1	1	1	1		1

Type	Code	Computer Programming Lab	L-T-P	Credits	Marks
ES	18ES1L03			0-0-4	2

<b>Objectives</b>	To enable the students to analyse problems, formulate and implement solutions using the C programming language. The students will develop logical understanding for converting solutions of problems into C programs to be executed on a computer.
<b>Pre-Requisites</b>	Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course.
<b>Teaching Scheme</b>	Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise of programming assignments.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to computers and Linux operating system.
2, 3	Get acquainted with the programming environment - Linux commands and VI-editor.
4	Editing, compiling, executing, and debugging of simple C programs.
5	Programs using operators and formatted input/output statements.
6	Decision making using if, if-else, else-if ladder, nested if.
7	Decision making using switch-case construct.
8, 9	Loop control structure (while, do-while, for) with jump statements.
10	Nested loops (printing various formats)
11, 12	1-D arrays including operation like searching, sorting, merging etc.
13	Handling 2-D arrays such as matrix operations.
14, 15	Programs on strings using various string handling functions (library functions)
16, 17	Designing user-defined functions.
18, 19	Programs on recursion.
20	Designing user defined functions for string manipulation.
21	Passing arrays (both 1D and 2D) to functions.
22, 23	Structure, array of structure, nested structure.
24	Dynamic memory management.
25	Self-referential structure (create and display operation of single linked list)
26, 27	File handling - reading from and writing to files.
28	Command-line argument, pre-processor directives.

#### Text Books:

- T1. E. Balagurusamy, *Programming in ANSI C*, 7<sup>th</sup> Edition, McGraw-Hill Education, 2017.
- T2. Y. Kanetker, *Let Us C*, 16<sup>th</sup> Edition, BPB Publications, 2018.

**Reference Books:**

- R1. B. W. Kernighan and D. M. Ritchie, *The C Programming Language*, 2<sup>nd</sup> Edition, Pearson Education, 2015.
- R2. H. Schildt, *C: The Complete Reference*, 4<sup>th</sup> Edition, McGraw-Hill, 2017.
- R3. A. Kelley and I. Pohl, *A Book on C*, 4<sup>th</sup> Edition, Pearson Education, 2008.
- R4. B. Gottfried, *Schaum's Outline of Programming with C*, 3<sup>rd</sup> Edition, McGraw-Hill, 2017.

**Online Resources:**

1. <https://www.w3resource.com/c-programming-exercises/>
2. <https://www.includehelp.com/c-programming-examples-solved-c-programs.aspx>
3. [https://www.onlinegdb.com/online\\_c\\_compiler](https://www.onlinegdb.com/online_c_compiler)
4. [https://www.tutorialspoint.com/compile\\_c\\_online.php](https://www.tutorialspoint.com/compile_c_online.php)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Construct C programs for mathematical operations using control statements.
CO2	Develop C programs for Array and String manipulation.
CO3	Construct modular programs for better maintenance and reusability.
CO4	Manipulate heterogeneous data using structure and union.
CO5	Create and manipulate files using C programs.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1								1	3		2
CO2	3	3	3	2								1	3		2
CO3	3	3	3	2								1	3		2
CO4	3	2	2	2								1	2		1
CO5	3	3	2	3								1	2		2

Type	Code	Communicative & Technical English Lab	L-T-P	Credits	Marks
HS	18HS1L01		0-0-2	1	100

<b>Objectives</b>	This laboratory course is designed to make students effective communicators and addressing issues like speaking inhibitions, accomplished by individual and team activities based on the four skills of language (LSRW).
<b>Pre-Requisites</b>	Basic knowledge of English grammar and the ability to speak, read and write using the English language.
<b>Teaching Scheme</b>	Regular laboratory classes with various tasks designed to facilitate communication through pair work, group/team work, individual and group presentations, discussions, role plays, listening to audios, watching videos, business writing and vocabulary enhancement.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Ice-breaking activities: dealing with inhibitions to speak (team activity)
2	Just a Minute (individual activity)
3	Role Play on channels of communication in the business world (team activity)
4	Speech activity 1: content development (individual activity)
5	Speech activity 2: for fluency, delivery and appropriate body language (individual activity)
6	Ear training: developing pronunciation skills (individual activity)
7	Listening comprehension: listening for overall and specific information (individual activity)
8	Oral presentations: preparing for public speeches (team activity)
9	Reading comprehension 1 (individual activity)
10	Reading comprehension 2 (individual activity)
11	Group presentation (team activity)
12	Writing Activity 1 (individual activity)
13	Writing Activity 2 (individual activity)

#### Text Books:

- T1. M. A. Rizvi, *Effective Technical Communication*, 2<sup>nd</sup> Edition, Tata McGraw Hill, 2017.
- T2. T. Balasubramaniam, *English Phonetics for Indian Students*, Trinity Press.
- T3. M. Raman and S. Sharma, *Technical Communication: Principles and Practices*, Oxford University Press.

#### Reference Books:

- R1. S. Samantray, *Business Communication and Communicative English*, S. Chand & Co.
- R2. J. Seeley, *The Oxford Guide to Writing and Speaking*, Oxford University Press.
- R3. B. K. Mitra, *Communication Skills for Engineers*, Oxford University Press, 2011.
- R4. B. K. Das, *An Introduction to Professional English & Soft Skills*, Cambridge Univ. Press, 2009.

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Speak in public and overcome their inhibitions to speak.
CO2	Communicate in simulated business contexts.
CO3	Develop English pronunciation skills through practice.
CO4	Work effectively as a member of a team or as a leader through group presentation assignments.
CO5	Critically analyse texts of various kind and compose effective business messages.

**Program Outcomes Relevant to the Course:**

PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1								1	1	3	1	3		3	3
CO2								1	3	3	2	3		2	2
CO3										3		3		2	2
CO4								2	3	3	2	3		3	3
CO5								1	1	3		3		2	3

Type	Code	Data Structures & Algorithms Lab	L-T-P	Credits	Marks
ES	18ES1L06			0-0-4	2

<b>Objectives</b>	Develop skills to design and analyze simple linear and non linear data structures. It strengthens the ability of students to identify and apply the suitable data structure for the given real world problem. It enables them to gain knowledge in practical applications of data structures.
<b>Pre-Requisites</b>	Knowledge of programming in C, specifically on structures, pointers, functions, recursion etc., are required.
<b>Teaching Scheme</b>	Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise of programming assignments.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Operations on arrays – insert, delete, merge.
2	Selection Sort, Bubble sort.
3	Linear Search and Binary search.
4	Representation of sparse matrix.
5, 6	Addition and transpose of sparse matrix.
7	Implementation of stack using array.
8	Conversion of infix to postfix expression.
9	Evaluation of postfix expression.
10	Operations of queue using array.
11	Operations of circular queue.
12	Single linked list operations.
13	Single linked list operations (continued).
14	Double linked list operations.
15	Double linked list operations (continued).
16	Circular linked list operations.
17	Stack using linked list.
18	Queue using linked list.
19	Polynomial addition using linked-list.
20	BST operations.
21	BST operations (continued).
22, 23	Graph traversal (BFS, DFS).
24	Warshall's shortest path algorithm.
25	Insertion Sort, quick sort.

Cont'd...



Experiment-#	Assignment/Experiment
26	Merge Sort.
27, 28	Implementation of Heap Sort.

**Text Books:**

- T1. E. Horowitz, S. Sahni, S. Anderson-Freed, *Fundamentals of Data Structures in C*, 2<sup>nd</sup> Edition, Universities Press, 2008.
- T2. M. A. Weiss, *Data Structures and Algorithm Analysis in C*, 2<sup>nd</sup> Edition, Pearson Education, 2002.

**Reference Books:**

- R1. A. K. Rath and A. K. Jagadev, *Data Structures Using C*, 2<sup>nd</sup> Edition, Scitech Publication, 2011.
- R2. Y. Kanetkar, *Data Structures Through C*, 2<sup>nd</sup> Edition, BPB Publication, 2003.

**Online Resources:**

1. <http://nptel.ac.in/courses/106102064/1>
2. <http://www.nptelvideos.in/2012/11/programming-and-data-structure.html>
3. [https://www.tutorialspoint.com/data\\_structures\\_algorithms/index.htm](https://www.tutorialspoint.com/data_structures_algorithms/index.htm)
4. <https://www.coursera.org/learn/data-structures/>
5. <https://www.geeksforgeeks.org/data-structures/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Implement various operations on array and sparse matrix.
CO2	Design functions to implement basic operations on stack & queue and apply them to solve real world problems.
CO3	Implement single, double & circular linked list and apply them in various real life applications.
CO4	Construct binary search tree and perform traversal, insertion, deletion, and search operations on it.
CO5	Perform BFS and DFS traversal operations in a graph and implement various sorting and searching algorithms.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	2		1						1	3		3
CO2	3	3	3	2		1						1	3		3
CO3	3	3	3	2		1						1	3		3
CO4	3	3	2	3		2						1	3		3
CO5	3	3	3	3		1						1	3		3

**Part II**

**2nd Year B. Tech. (ECE)**

## Curriculum Structure

Semester III								
Type	Code	Course Title	WCH			Credits		
			L	T	P	L	T	P
<b>THEORY</b>								
BS	18BS1T03	Math-III for ECE/EEE/EIE	3	0	0	3	0	0
PC	18EE1T01	Circuit Theory	3	0	0	3	0	0
ES	18ES1T06	OOP Using Java	3	0	0	3	0	0
PC	18EC1T02	Electronic Devices	3	0	0	3	0	0
PC	18EC1T03	Digital Electronic Circuits	3	0	0	3	0	0
HS	18HS1T03	Fundamentals of Management	3	0	0	3	0	0
<b>PRACTICAL</b>								
ES	18ES1L07	OOP Using Java Lab	0	0	2	0	0	1
PC	18EE1L01	Circuit Theory Lab	0	0	2	0	0	1
PC	18EC1L01	Digital Electronic Circuits Lab	0	0	2	0	0	1
MC	18NC7L01	Yoga	0	0	2	0	0	0
PJ	18IR6L01	Summer Internship-I	0	0	0	0	0	1
		<b>SUB-TOTAL</b>	<b>18</b>	<b>0</b>	<b>8</b>	<b>18</b>	<b>0</b>	<b>4</b>
		<b>TOTAL</b>	<b>26</b>			<b>22</b>		

Semester IV								
Type	Code	Course Title	WCH			Credits		
			L	T	P	L	T	P
<b>THEORY</b>								
BS	18BS1T04	Math-IV for ECE/EEE/EIE	3	0	0	3	0	0
ES	18ES1T08	Basics of Mechanical Engineering	3	1	0	3	1	0
HS	18HS1T02	Engineering Economics	3	0	0	3	0	0
PC	18EC1T04	Microprocessor & Microcontrollers	3	0	0	3	0	0
PC	18EI1T01	Analog Electronic Circuits	3	0	0	3	0	0
PC	18EE1T02	Measurements & Instrumentation	3	0	0	3	0	0
<b>PRACTICAL</b>								
PC	18EC1L02	Microprocessor & Microcontrollers Lab	0	0	2	0	0	1
PC	18EI1L01	Analog Electronic Circuits Lab	0	0	2	0	0	1
PC	18EE1L02	Measurements & Instrumentation Lab	0	0	2	0	0	1
		<b>SUB-TOTAL</b>	<b>18</b>	<b>1</b>	<b>6</b>	<b>18</b>	<b>1</b>	<b>3</b>
		<b>TOTAL</b>	<b>25</b>			<b>22</b>		

Type	Code	Math-III for ECE/EEE/EIE	L-T-P	Credits	Marks
BS	18BS1T03		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to provide the knowledge of Fourier Transforms, analytic functions, poles & zeros, residue calculus, and other special functions important for study of electrical sciences.
<b>Pre-Requisites</b>	Knowledge of calculus of single variable, coordinate geometry of two and three dimensions, matrix algebra, and ordinary differential equations is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Basics of Complex Numbers, Derivatives, Analytic Functions, C-R Equations, Basic elementary Complex functions.	<b>8 Hours</b>
<b>Module-2</b>	Complex Line Integration, Integral Theorems, Complex Power Series and Taylor Series.	<b>8 Hours</b>
<b>Module-3</b>	Laurent Series, Residue Integration and its application for evaluation of real integrals.	<b>8 Hours</b>
<b>Module-4</b>	Periodic function and Fourier series, Euler formula, Even and odd functions, Half range expansions, Fourier integrals, Fourier cosine transform, Fourier sine transform, Fourier transform.	<b>10 Hours</b>
<b>Module-5</b>	Power series solutions to ordinary differential equations, Legendre Equation, Bessel's function and its properties, Gamma function, Beta function, Error function.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

T1. E. Kreyszig, *Advanced Engineering Mathematics*, 8<sup>th</sup> Edition, Wiley India, 2015.

#### Reference Books:

- R1. S. Pal and S. C. Bhunia, *Engineering Mathematics*, 1<sup>st</sup> Edition, Oxford University Press, 2015.  
 R2. B. V. Ramana, *Higher Engineering Mathematics*, 1<sup>st</sup> Edition, McGraw-Hill, 2017.

#### Online Resources:

- <http://www.nptel.ac.in/courses/111105035>
- <http://www.nptel.ac.in/courses/122104017>
- <http://nptel.ac.in/courses/122102009>
- <http://nptel.ac.in/courses/111107063>
- <https://www.coursera.org/learn/linearalgebra2>
- <https://www.coursera.org/learn/differentiation-calculus>
- <https://www.coursera.org/learn/single-variable-calculus>
- <https://alison.com/courses/Algebra-Functions-Expressions-and-Equations>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand the concepts of Analytic function.
CO2	Evaluate complex line integral and find the Taylor's series expansion of analytic functions.
CO3	Expand functions in Laurent's Series and evaluate integrations using residues.
CO4	Find the Fourier series and Fourier transforms of functions.
CO5	Understand the concepts of power series solution and some important special functions.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	1								2	1	1
CO2	3	3	2	1	2								2	1	1
CO3	3	3	3	3	1								2	1	1
CO4	3	3	3	2	3								3	1	1
CO5	3	3	2	2	2								2	1	1

Type	Code	Circuit Theory	L-T-P	Credits	Marks
PC	18EE1T01		3-0-0	3	100

<b>Objectives</b>	The objective of this course is that the student should be able to analyze any circuit configuration, synthesize circuits with any given specifications or network functions, test and improve the design as required.
<b>Pre-Requisites</b>	Basics of Circuit analysis, Laplace transform, Fourier transform and Differential equations are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Network Theorems: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Maximum power transfer theorem, Tellegen's theorem, Millman's theorem, Compensation theorem (AC & DC Networks); Coupled Circuits: Introduction to coupled Circuit, Dot Convention, coefficient of coupling, Electrical equivalent of magnetically coupled coils, Series and parallel connection of coupled coils. Transformer as a magnetically coupled circuit; Resonance: Introduction, Series Resonance, Parallel Resonance, Quality factor, Bandwidth and Selectivity for series resonant and parallel resonant circuits, Frequency Response Curve.	<b>10 Hours</b>
<b>Module-2</b>	Laplace Transform & its Application: Introduction, Laplace transform of some basic functions, Laplace transform of periodic functions, Inverse Laplace transform, initial and final value theorem; Application Of Laplace Transform for Transient Analysis: Response of RL, RC & RLC network with step, sinusoidal, impulse and ramp input.	<b>8 Hours</b>
<b>Module-3</b>	Two Port Network Functions & Responses: Introduction, z, y, ABCD and h-parameters, Reciprocity and Symmetry, Interrelation of two-port parameters, Interconnection of two-port networks; Network Functions & Response: Transfer function and driving point function for one & two port networks, Concept of poles and zeros, Significance & Restriction on location of Poles and Zeros, Time domain behavior from Pole-Zero plots.	<b>6 Hours</b>
<b>Module-4</b>	Fourier Series & its Application: Fourier series, Fourier analysis and evaluation of coefficients, Steady state response of network to periodic signals; Fourier Transform: Fourier transform of some basic functions, Properties of Fourier Transform; Application of Fourier transform to electrical network; Filter: Introduction, Types and classification of Filter, introduction to design parameters of passive filter, Design of active filters and their frequency response.	<b>12 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	Network Synthesis: Hurwitz polynomial and its properties, Positive real functions and their properties, Concepts of network synthesis, Realization of simple R-L, R-C and L-C functions in Cauer-I, Cauer-II, Foster-I and Foster-II forms.	8 Hours
<b>Total</b>		<b>44 Hours</b>

**Text Books:**

- T1. M. E. Van Valkenburg, *Network Analysis*, 3<sup>rd</sup> Edition, Pearson Education, 2015.  
 T2. C. K. Alexander and M. N. O. Sadiku, *Fundamentals of Electric Circuits*, 5<sup>th</sup> Edition, Tata McGraw-Hill, 2013.  
 T3. A Chakrabarti, *Circuit Theory: Analysis and Synthesis*, 7<sup>th</sup> Edition, Dhanpat Rai & Co., 2013.

**Reference Books:**

- R1. S. Ghosh, *Network Theory: Analysis And Synthesis*, 1<sup>st</sup> Edition, Prentice Hall of India, 2009.  
 R2. P. K. Satpathy, P. Kabisatpathy, S. P. Ghosh, and A. K. Chakraborty, *Network Theory*, 1<sup>st</sup> Edition, Tata McGraw-Hill, 2009.

**Online Resources:**

- <https://nptel.ac.in/courses/108102042/>
- <https://nptel.ac.in/courses/108106075/>
- <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/lecture-notes/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Apply concepts of network theorems and coupled circuits in solving complex networks problems and frequency response and analysis of different resonant circuits.
CO2	Understand the switching phenomena of electrical circuits and evaluate transient and steady state performance using Laplace Transformation.
CO3	Determine two-port network parameters and their practical application to electrical and electronic circuits.
CO4	Analyze sinusoidal & non-sinusoidal signals using Fourier series and transform, identify & design various filters and examine their frequency response.
CO5	Identify Network Functions and synthesize one port network using Foster and Cauer forms.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

*Cont'd...*



PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	2	1						1	3	1	
CO2	3	3	1	2	2	2						1	3	1	
CO3	3	3	1	2	2							1	3	1	
CO4	3	3	1	2	2							1	3	1	
CO5	3	3	1	2	1							1	3	1	

Type	Code	OOP Using Java	L-T-P	Credits	Marks
ES	18ES1T06			3-0-0	3

<b>Objectives</b>	The objective of this course is to introduce the key concepts of object-oriented programming (OOP) using Java as the programming language.
<b>Pre-Requisites</b>	Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course. Prior experience with a programming language will be beneficial.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Object oriented concepts: Object oriented systems development life cycle, Unified Modeling Language, UML class diagram, Use-case diagram; Java Overview: Java Virtual Machine, Java buzz words, Data types, Operators, Control statements, Class fundamentals, Objects, Methods, Constructors, Overloading, Access modifiers.	<b>9 Hours</b>
<b>Module-2</b>	Inheritance: Basics of Inheritance, using super and final keyword, method overriding, Abstract classes, defining and importing packages, access protection, interfaces; Exception handling: Exception fundamentals, types, understanding different keywords (try, catch, finally, throw, throws), User defined exception handling.	<b>8 Hours</b>
<b>Module-3</b>	Input/Output: Files, stream classes, reading console input; Threads: thread model, use of Thread class and Runnable interface, thread synchronization, multithreading, inter thread communication.	<b>8 Hours</b>
<b>Module-4</b>	String manipulation: Basics of String handling, String class, StringBuilder, StringBuffer, StringTokenizer. Applet basics and life cycle; Event Handling: delegation event model, event classes, sources, listeners, Adapter class.	<b>8 Hours</b>
<b>Module-5</b>	Introduction to GUI Programming: working with windows, frames, graphics, color, and font. AWT Control fundamentals. Swing overview; JavaFX overview; Java database connectivity: JDBC overview, creating and executing queries, dynamic queries.	<b>9 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. H. Schildt, *Java: The Complete Reference*, 10<sup>th</sup> Edition, McGraw-Hill, 2017.
- T2. Y. D. Liang, *Introduction to Java Programming*, 9<sup>th</sup> Edition, Pearson Education, 2012.

#### Reference Books:

- R1. B. Bates, K. Sierra, *Head First Java*, 2<sup>nd</sup> Edition, O'Reilly Media, 2005.
- R2. T. Budd, *An Introduction to Object-Oriented Programming*, 3<sup>rd</sup> Edition, Pearson Education, 2009.
- R3. I. Horton, *Beginning Java*, 7<sup>th</sup> Edition, Wrox Publications, 2011.

**Online Resources:**

1. <https://nptel.ac.in/courses/106105191/>
2. <https://docs.oracle.com/javase/tutorial/>
3. <http://www.javatpoint.com/java-tutorial>
4. <http://www.w3schools.in/java/>
5. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-00-introduction-to-computer-science-and-programming-fall-2008/video-lectures/lecture-14/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Apply object oriented principles in software design process to develop Java programs for real life applications.
CO2	Employ inheritance and exception handling techniques for developing robust and reusable software.
CO3	Develop programs using stream classes for various I/O operations and design concurrent programs using threads to maximize the use of processing power.
CO4	Design applications for text processing using String class and develop user interactive applications using event handling.
CO5	Design database driven GUI applications using AWT, Swing and JDBC.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1		1						2	3		3
CO2	3	2	2	1		1						2	3		3
CO3	3	1	2	2		1						2	3		3
CO4	3	2	3	1		1						2	3		3
CO5	3	2	3	1		1						2	3		3

Type	Code	Electronic Devices	L-T-P	Credits	Marks
PC	18EC1T02		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to encourage the students to understand the underlying physics of semiconductor devices and its application in understanding and designing different semiconductor devices in both academic institutions and industries.
<b>Pre-Requisites</b>	Basic knowledge on solid state physics including quantum physics of electrons in isolated atom and group of atoms is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
	<b>Introduction:</b> Review of quantum mechanics, Electrons in periodic lattices, E-K diagrams, Energy bands in solids.	<b>2 Hours</b>
<b>Module-1</b>	<b>Electrons and Holes in Semiconductors:</b> Silicon crystal structure, Donors and acceptors in the band model, effective mass, Density of states (D(E)), Thermal equilibrium, Fermi-Dirac distribution function (f(E)) for electrons and holes, Fermi energy, Derivation of equilibrium concentration of electrons(n) and holes (p) from D(E) and f(E), Fermi level and carrier concentrations, np product and intrinsic carrier concentration.	<b>8 Hours</b>
<b>Module-2</b>	<b>Electrons, Holes and their Transport Phenomena in Semiconductors:</b> Carrier concentrations at extremely high and low temperatures: complete ionization, partial ionization and freeze-out, Energy-band diagram and Fermi-level, Variation of $E_f$ with doping concentration and temperature; Carrier drift: Electron and hole mobilities, Drift current and conductivity and resistivity; Carrier diffusion: diffusion current, Total current density, Thermal generation, Electron-hole recombination.	<b>8 Hours</b>
<b>Module-3</b>	<b>PN Junction Diode and Schottky Diode:</b> P-N junction characteristics; Building blocks of the pn junction theory, Energy band diagram and depletion layer of a pn junction, Built-in potential, Carrier injection under forward bias-Quasi-equilibrium boundary condition; current continuity equation, I-V characteristics, Reverse biased P-N junction: Avalanche breakdown, Zener diode, Schottky diode: I-V characteristics, Comparison between Schottky barrier diode and pn-junction diode.	<b>9 Hours</b>
<b>Module-4</b>	<b>MOS Capacitor and MOSFET:</b> The MOS structure, Energy band diagrams, Surface accumulation, Surface depletion, Flat-band condition and flat-band voltage, Threshold condition and threshold voltage, C-V characteristics of ideal MOS capacitor, Basic structure of MOSFET, MOSFET $V_t$ , $Q_{inv}$ and I-V Characteristics.	<b>9 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Integrated Circuit Fabrication Process:</b> Oxidation, Diffusion, Ion implantation, Photolithography, Etching, Chemical vapor deposition, Sputtering and twin tube CMOS process.	6 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. D. A. Neamen, *Semiconductor Physics and Devices*, 4th Ed., McGraw-Hill, 2012.
- T2. G. Streetman and S. K. Banerjee, *Solid State Electronic Devices*, 7th Ed., Pearson, 2014.

**Reference Books:**

- R1. S. M. Sze and K. N. Kwok, *Physics of Semiconductor Devices*, 3rd Ed., John Wiley & Sons, 2006.
- R2. C. T. Sah, *Fundamentals of Solid State Electronics*, 1st Ed., World Scientific Publishing Co., 1991.
- R3. D. A. Neamen and D. Biswas, *Semiconductor Physics and Devices*, 4th Ed., Tata McGraw-Hill Education, 2012.
- R4. Y. Tsididis and M. Colin, *Operation and Modelling of MOS Transistor*, 3rd Ed., Oxford University Press, 2011.
- R5. C. C. Hu, *Modern Semiconductor Devices for Integrated Circuits*, 1st Ed., Pearson, 2010.

**Online Resources:**

1. <https://nptel.ac.in/courses/115102103/>: Semiconductor Optoelectronics
2. <https://nptel.ac.in/courses/113104012/>: Optoelectronic Materials and Devices

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Analyze the charge carrier statistics in semiconductors for the calculation of built in potential, electric field and depletion barrier width etc.
CO2	Investigate the carrier transport phenomena such as drift and diffusion and their relationship (Einstein's relationship) to calculate the conductivity of semiconductor devices.
CO3	Apply the theory of carriers like concentrations and transport to investigate the electronic properties of pn junction diode and Schottky diode under equilibrium and non-equilibrium conditions.
CO4	Investigate the C V Characteristics of MOS capacitor and I V characteristics of MOSFET.
CO5	Understand the basic fabrication steps in CMOS Technology.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

*Cont'd...*

PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2									3	1	2
CO2	3	3	2	2									3		2
CO3	3	3	3	1	1								3	1	1
CO4	3	1	2	2									3		2
CO5	3	2	3	3									3	2	2

Type	Code	Digital Electronic Circuits	L-T-P	Credits	Marks
PC	18EC1T03			3-0-0	3

<b>Objectives</b>	The objective of this course is to understand the concepts & techniques associated with digital systems and their design & implementations in VLSI technology.
<b>Pre-Requisites</b>	Knowledge of Basic Electronics and fundamentals of Number Systems is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Fundamental Concepts:</b> Introduction, Digital Signals, Basic Digital Circuits, Different Logic Gates and their Logic Operations, Universal Logic Gates, Complete Logic Sets. Examples of IC Gates; Logic Families – TTL and CMOS Logic Families, Implementation of logic gates using TTL and CMOS logic; <b>Number Systems and Codes:</b> Number Systems, Binary Number System, Signed Binary Numbers, Binary Arithmetic, 1's and 2's Complement Arithmetic, Octal Number System, Hexadecimal Number System, Codes, Error Detecting and Correcting Codes.	<b>8 Hours</b>
<b>Module-2</b>	<b>Combinational Logic Design:</b> Boolean Algebra and Identities, Algebraic Reduction and Realization using Logic Gates and Universal Logic Gates; Standard Representation for Logic Functions: Sum-of-Products (SOP) and Product-of-Sums (POS) forms, Canonical SOP and POS forms; K-map representation and simplification of logic functions using K-map, Minimization of 2, 3, 4 variable logical functions; Don't care conditions; <b>Combinational Logic Components:</b> Multiplexer, De-Multiplexer, Decoders, Encoder (Priority Encoder), Design of Combinational Circuits using Multiplexer and Decoder, Adders, Subtractors, Carry-Look-Ahead Adder, Binary Multiplier, An Equality Detector and Comparator, BCD to 7-Segment Display Decoder.	<b>9 Hours</b>
<b>Module-3</b>	<b>Sequential Logic Design(Flip-Flops and FSMs):</b> Flip Flops – A 1-bit memory, Bistable latch (SR and D), the clocked SR flip flop, J-K, T and D type flip-flops, Race Around Condition, Master Slave JK-flip flop, Conversion of flip-flops; Finite State Machines (FSMs) – Mealy and Moore models of Finite State Machines.	<b>9 Hours</b>
<b>Module-4</b>	<b>Sequential Logic Design (Shift Registers and Counters):</b> Shift Registers – SISO, SIPO, PISO, PIPO and Universal Shift Register, Applications of Shift Registers (Serial to Parallel Converter, Parallel to Serial Converter), Ring Counter, Twisted Ring Counter (Johnson Counter); Counters – Design of Ripple (Asynchronous) Counters (Up/Down Counter, Mod-N Counter), Design of Synchronous Counters, Gray Code Counter and Random Sequence Counter using State Diagrams.	<b>8 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Programmable Logic Devices:</b> Programmable Logic Array (PLA), Programmable Array Logic (PAL), Complex Programmable Logic Devices (CPLDs); <b>Semiconductor Memories:</b> Basics of ROM, SRAM & DRAM; <b>Basic Hardware Description Language:</b> Introduction to VHDL programming language, Different Modeling Styles (Dataflow, Behavioral and Structural), Data types and Objects, VHDL program combinational and sequential circuits.	8 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. M. M. Mano and M. D. Ciletti, *Digital Design: With an Introduction to Verilog HDL*, 5<sup>th</sup> Edition, Pearson Education, 2013.
- T2. L. K. John and C. H. Roth Jr., *Digital System Design using VHDL*, 2<sup>nd</sup> Edition, Cengage Learning, 2012.

**Reference Books:**

- R1. D. V. Hall, *Digital Circuits and Systems*, International Student Edition, McGraw-Hill Education, 1989.
- R2. A. A. Kumar, *Fundamentals of Digital Circuits*, 3<sup>rd</sup> Edition, PHI Learning, 2014.
- R3. R. P. Jain, *Modern Digital Electronics*, 4<sup>th</sup> Edition, McGraw-Hill Education, 2009.
- R4. W. H. Gothmann, *Digital Electronics - An Introduction to Theory and Practice*, 2<sup>nd</sup> Edition, PHI Learning, 1982.
- R5. J. F. Wakerly, *Digital Design: Principles and Practices*, 4<sup>th</sup> Edition, Pearson Education, 2008.
- R6. J. P. Uyemura, *A First Course in Digital System Design : An Integrated Approach*, Vikas-Thomson Learning, 2002.
- R7. R. J. Tocci, N. S. Widemer, and G. L. Moss, *Digital Systems - Principles and Applications*, 11<sup>th</sup> Edition, Pearson Education, 2010.
- R8. A. Agarwal and J. Lang, *Foundations of Analog and Digital Electronic Circuits*, 1<sup>st</sup> Edition, Morgan Kaufmann, 2005.

**Online Resources:**

1. <https://nptel.ac.in/courses/117106086/>
2. <https://swayam.gov.in/course/1392-digital-circuits-and-systems>
3. <https://nptel.ac.in/courses/117103064/>
4. <https://nptel.ac.in/courses/117105080/3>
5. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/video-lectures/>
6. <http://www.allaboutcircuits.com>
7. <https://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/>

**Course Outcomes:** At the end of this course, the students will be able to:

CO1	Become familiar with various number systems, codes and Boolean algebra.
CO2	Design and analyze combinational logic circuits.
CO3	Design & analyze various sequential logic circuits and be familiar with counter design.
CO4	Design, analyze and implement memory array using sequential network for digital logic & investigate performance of CMOS based logic circuits in modern VLSI technology.
CO5	Simulate and synthesize various digital circuits using VHDL in industry standard tools such as Xilinx, Mentor Graphics etc.



**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	3	2	1							3	1	
CO2	2	3	2	3	3	1							3	1	
CO3	2	3	2	3	3	1							3	1	
CO4	2	3	2	3	2	1							3	1	
CO5	2	3	2	3	2	1							3	1	

Type	Code	Fundamentals of Management	L-T-P	Credits	Marks
HS	18HS1T03		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to provide basic knowledge on management of business, finance, marketing, and human resources, which will help the students to grow from a team player to a good manager in an enterprise.
<b>Pre-Requisites</b>	General knowledge of any organization and its operations is sufficient.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with real-life examples.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Concepts of Management:</b> Management as an art or science, the process of management, managerial skills, good managers are born, not made, management is concerned with ideas, things and people, inducing workers to put in their best, levels and types of management, evolution of management thought, managerial environment.	<b>8 Hours</b>
<b>Module-2</b>	<b>Functions of Management:</b> Planning and its features and process, types of plan, effective planning, Organizing and its process, formal and informal organization, directing and its elements, staffing and functions, controlling & its features and process, tools of controlling.	<b>6 Hours</b>
<b>Module-3</b>	<b>Marketing Function:</b> Modern concepts of marketing, marketing vs. selling, functional classification of marketing, functions of marketing management, marketing process; Marketing Mix: product and types of product, product life cycle, development of a new product, price, factors affecting price, pricing strategies; Distribution channel: role and functions, selection of a distribution channel, promotion and types of promotion, developing an advertising campaign, promotional strategies.	<b>12 Hours</b>
<b>Module-4</b>	<b>Financial Function:</b> Scope and objectives, financial functions, sources of finance, project appraisal, tools of financial decisions making, overview of working capital.	<b>6 Hours</b>
<b>Module-5</b>	<b>HRM Function:</b> Human Resource Management, Human Resource Development, importance of HRM, overview of job Analysis, job description, job specification, labour turnover; Manpower planning, recruitment, selection, induction, training and development, placement, wage and salary administration, performance appraisal, grievance handling, welfare aspects.	<b>10 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. S. A. Sherlekar and V. S. Sherlekar, *Modern Business Organization & Management*, 4<sup>th</sup> Edition, Himalaya Publishing House, 2018.

**Reference Books:**

- R1. C. R. Basu, *Business Organization & Management*, 4<sup>th</sup> Edition, TMH, 2010.
- R2. P. C. Tulsian and V. Pandey, *Business Organization & Management*, 1<sup>st</sup> Edition, Pearson, 2002.
- R3. P. Kotler, K. L. Keller, A. Koshy, and M Jha, *Marketing Management*, 14<sup>th</sup> Edition, Pearson, 2012.
- R4. I. M. Pandey, *Financial Management*, 11<sup>th</sup> Edition, Vikas Publishing, 2015.
- R5. K. Aswasthapa, *Human Resource Management: Text and Cases*, 7<sup>th</sup> Edition, TMH, 2013.

**Online Resources:**

1. <https://nptel.ac.in/courses/122108038/>
2. <https://iedunote.com/marketing-concept>
3. <https://www.tutorsonnet.com/functions-of-distribution-channel-homework-help.php>
4. <https://www.managementstudyhq.com/financial-function-types-importance-objectives.html>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the basic concepts of management and organization.
CO2	Explain fundamental management functions such as planning, directing, organizing, leading and controlling.
CO3	Adopt marketing policy by applying modern concept of marketing and select appropriate distribution channels.
CO4	Apply knowledge of financial functions in management for decision making.
CO5	Utilize the concepts of HRM functions to manage & develop human resources in an organization.

**Program Outcomes Relevant to the Course:**

PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1	1		2		3	1		2	1
CO2									1		3	2		2	2
CO3						1	1		1		2	2		1	1
CO4											3	2		1	2
CO5						1	1		3		3	1		1	1

Type	Code	OOP Using Java Lab	L-T-P	Credits	Marks
ES	18ES1L07			0-0-2	1

<b>Objectives</b>	The objective of the course is to apply object oriented programming principles and implement object oriented programming using JAVA language.
<b>Pre-Requisites</b>	Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course. Prior experience with any other object oriented programming language will be beneficial.
<b>Teaching Scheme</b>	Regular laboratory classes with the use of ICT whenever required, demonstration through practical simulation of code using IDE.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Understanding Java platform, compilation, and execution of a java program.
2	Overview of Eclipse IDE.
3	Use of class, use of control statements, data types, operators.
4	Implement class, object, constructor, methods, and other OOP features.
5	Inheritance Basics, more uses of constructor, method overriding, use of final.
6	Object class, practical use of abstract class.
7	Using Interface for achieving multiple inheritance, implementation of package.
8	Exception handling fundamentals, java built-in exceptions, Use of Scanner class for console input, use of own Exception subclass.
9	Java thread life cycle model and implementation approach, thread priority, implementation of synchronization.
10	I/O Basics, byte stream and character streams, reading and writing files.
11	Applet life cycle implementation, text processing using Java predefined String, StringBuilder and StringBuffer classes.
12	GUI basics and Window fundamentals, working with different Component, Container and Layout Managers.
13	Event handling for interactive GUI application.
14	Java database connectivity using JDBC, steps and use of different drive types.

#### Text Books:

- T1. H. Schildt, *Java: The Complete Reference*, 9<sup>th</sup> Edition, McGraw-Hill, 2011.
- T2. Y. D. Liang, *Introduction to Java Programming*, 9<sup>th</sup> Edition, Pearson Education, 2012.

#### Reference Books:

- R1. B. Bates, K. Sierra, *Head First Java*, 2<sup>nd</sup> Edition, O'Reilly Media, 2005.
- R2. T. Budd, *An Introduction to Object-Oriented Programming*, 3<sup>rd</sup> Edition, Pearson Education, 2009.
- R3. I. Horton, *Beginning Java*, 7<sup>th</sup> Edition, Wrox Publications, 2011.

**Online Resources:**

1. <https://nptel.ac.in/courses/106105191/>
2. <https://docs.oracle.com/javase/tutorial/>
3. <http://www.javatpoint.com/java-tutorial>
4. <http://www.w3schools.in/java/>
5. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-00-introduction-to-computer-science-and-programming-fall-2008/video-lectures/lecture-14/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Apply object oriented principles in software design process and develop Java programs for real-life applications.
CO2	Employ inheritance and exception handling techniques for developing robust, reusable software.
CO3	Develop programs using stream classes for various I/O operations and design concurrent programs using threads to maximize the use of processing power.
CO4	Design applications for text processing using String class and develop user interactive applications using event handling.
CO5	Design database driven GUI applications using AWT, Swing and JDBC.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1		1						2	3		3
CO2	3	2	2	1		1						2	3		3
CO3	3	1	2	2		1						2	3		3
CO4	3	2	3	1		1						2	3		3
CO5	3	2	3	1		1						2	3		3

Type	Code	Circuit Theory Lab	L-T-P	Credits	Marks
PC	18EE1L01		0-0-2	1	100

<b>Objectives</b>	The objective of the course is to provide practical working knowledge of network theory and recording the experimental data effectively and correctly.
<b>Pre-Requisites</b>	Basic knowledge of electrical & electronics engineering, Laplace transform and differential equations is required.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted using hardware and software tools under the supervision of the teacher. Demonstration along with required safety measures will be explained for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Verification of Network Theorems (Superposition, Thevenin, Norton, Maximum Power Transfer) both in DC & AC.
2	Study of DC and AC Transients.
3	Determination of circuit parameters: Open Circuit and Short Circuit parameters.
4	Determination of circuit parameters: Hybrid and Transmission parameters.
5	Frequency response of Low pass and High Pass Filters.
6	Frequency response of Band pass and Band Elimination Filters.
7	Determination of self inductance, mutual inductance and coupling coefficient of a single phase two winding transformer representing a coupled circuit.
8	Study of resonance in R-L-C series circuit.
9	Study of resonance in R-L-C parallel circuit.
10	Spectral analysis of a non-sinusoidal waveform.

#### Text Books:

- T1. M. E. Van Valkenburg, *Network Analysis*, 3<sup>rd</sup> Edition, Pearson Education, 2015.
- T2. C. K. Alexander and M. N. O. Sadiku, *Fundamentals of Electric Circuits*, 5<sup>th</sup> Edition, Tata McGraw-Hill, 2013.
- T3. A Chakrabarti, *Circuit Theory: Analysis and Synthesis*, 7<sup>th</sup> Edition, Dhanpat Rai & Co., 2013.

#### Reference Books:

- R1. S. Ghosh, *Network Theory: Analysis And Synthesis*, 1<sup>st</sup> Edition, Prentice Hall of India, 2009.
- R2. P. K. Satpathy, P. Kabisatpathy, S. P. Ghosh, and A. K. Chakraborty, *Network Theory*, 1<sup>st</sup> Edition, Tata McGraw-Hill, 2009.

#### Online Resources:

1. <https://nptel.ac.in/courses/108102042/>
2. <https://nptel.ac.in/courses/108106075/>
3. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/lecture-notes/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Gain knowledge on procedures to conduct experiments safely, analyze results and develop technically sound report of outcomes.
CO2	Relate the co-relation between frequency and circuit parameters at resonance condition.
CO3	Design of different configurations in electrical networks.
CO4	Employ concept of coupled circuits to electrical machines.
CO5	Analyze sinusoidal & non-sinusoidal signals using Fourier series and transform.
CO6	Identify & design various filters and examine their frequency response.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	1						2	3	1	1
CO2	2	1	1	2	1							1	2	1	
CO3	2	2	1	2	1							1	2	1	
CO4	1	1	1	1	1							1	1		
CO5	3	3	1	1	1							2	2	1	
CO6	3	2	1	3	2	1						2	2	1	

Type	Code	Digital Electronic Circuits Lab	L-T-P	Credits	Marks
PC	18EC1L01			0-0-2	1

<b>Objectives</b>	The objective of the course is to hands-on exposure on logic gates, implementation using Boolean algebra, designing digital circuits like counters, registers and apply the knowledge to formulate digital systems using HDL.
<b>Pre-Requisites</b>	Knowledge of Basic Electronics is required.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted under supervision of the faculty with use of ICT as and when required, sessions are planned to be interactive with focus on implementation in hardware / software tools.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Digital Logic Gates: Investigate logic behaviour of AND, OR, NAND, NOR, EX-OR, EX-NOR, Invert and Buffer gates, use of Universal NAND Gate.
2	Combinational Circuit Design: Design, assemble and test: adders and subtractors.
3	Combinational Circuit Design: Code Converters, Gray code to Binary and 7 Segment Display.
4	Universal Gates: Design, implement and test a given design example with (i) NAND Gates only (ii) NOR Gates only and (iii) using minimum number of Gates.
5	Multiplexer and De-multiplexer: Design with multiplexers and de-multiplexers.
6	Flip-Flop: Assemble, test and investigate operation of SR, D & J-K flip-flops.
7	Shift Registers: Design and investigate the operation of all types of shift registers.
8	Counters: Design, assemble and test various ripple and synchronous counters - decimal counter, Binary counter with parallel load.
9	Parallel Adder and Accumulator: Design, implement and test.
10	Binary Multiplier: design and implement a circuit that multiplies 4-bit unsigned numbers to produce an 8-bit product.
11	Memory Unit: Investigate the behaviour of RAM unit and its storage capacity – 16×4 RAM: testing, simulating and memory expansion.
12	Clock-pulse generator: Design, implement and test.
13	Verilog/VHDL Simulation and implementation of Experiments 2 to 12.

#### Text Books:

- T1. M. M. Mano and M. D. Ciletti, *Digital Design: With an Introduction to Verilog HDL*, 5<sup>th</sup> Edition, Pearson Education, 2013.

#### Reference Books:

- R1. A. M. Michelén, *Digital Electronics Laboratory Manual*, Pearson Education, 2000.  
 R2. J. W. Stewart and C. -Y. Wang, *Digital Electronics Laboratory Experiments: Using the Xilinx XC95108 CPLD with Xilinx Foundation : Design and Simulation Software*, 2<sup>nd</sup> Edition, Pearson, 2004.



**Online Resources:**

1. <https://www2.mvcc.edu/users/faculty/jfiore/Resources/DigitalElectronics1LaboratoryManual.pdf>
2. <https://www.elprocus.com/top-digital-electronic-projects-for-electronics-engineering-students/>
3. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-111-introductory-digital-systems-laboratory-spring-2006/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Analyse the function of logic gates and implementation of Boolean functions.
CO2	Realize Universal gates and Implementation of minimized Boolean Expressions.
CO3	Design and analyze different combinational circuits.
CO4	Design various asynchronous and Synchronous Sequential Circuits.
CO5	Acquire knowledge about internal circuitry and logic behind any digital system.
CO6	Simulate various digital circuits using VHDL in industry standard tool such as Xilinx.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	3	2	1							3	1	
CO2	2	3	3	3	3	1							3	1	
CO3	2	3	3	3	3	1							3	1	
CO4	2	3	2	3	2	1							3	1	
CO5	2	3	2	3	2	1							3	1	
CO6	2	3	2	3	2	1							3	1	

Type	Code	Yoga	L-T-P	Credits	Marks
MC	18NC7L01		0-0-2	0	100

<b>Objectives</b>	To impart skills in students for control of mind, body and soul, enhance self-awareness, focus, and concentration, bring together physical and mental wellness, manage stress and anxiety, achieve perfect equilibrium and harmony of body & mind, and promote self-healing.
<b>Pre-Requisites</b>	There are no pre-requisites for this course.
<b>Teaching Scheme</b>	Regular practice classes conducted under supervision of the qualified Yoga teacher with necessary explanation and demonstration for each session.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction; introduction of Yoga
2	<i>Pranayama</i> ; performing breathing exercise
3	<i>Mudra</i> ; learning various types of <i>Mudras</i> and their benefits
4	<i>Bandha</i> ; learning various types of <i>Bandhas</i> and their benefits
5	<i>Chakra</i> ; learning various types of <i>Chakras</i> and their benefits
6	<i>Chakshu Visrant Asana Samuha</i> ; eye movement and exercises
7	Twisting set; standing twisting asana
8	Side stretching set; standing Side stretching <i>asana</i>
9	Forward bending set; standing Forward bending <i>asana</i>
10	Backward bending set; standing Backward bending <i>asana</i>
11	Balancing set; learning <i>Vrikshasana</i> , <i>Ekpada Pranamasana</i> and benefits
12	<i>Surya Namaskar</i> ; surya namaskar mantra and poses
13	<i>Vajrasana</i> set; sitting <i>asana</i> sets
14	<i>Padmasana</i> set; sitting <i>asana</i> sets
15	Sleeping asana and <i>Yoga Nidra</i> ; relaxation postures

#### Text Books:

T1. E. F. Bryant, *The Yoga Sutras of Patanjali*, 1<sup>st</sup> Edition, North Point Press, 2009.

#### Reference Books:

R1. Swami Satyananda Saraswati, *Asana Pranayama Mudra Bandha*, 4<sup>th</sup> Edition, Yoga Publication Trust, Munger (Bihar), India, 2008.

**Online Resources:** There are a number of online resources available for this course. The student is advised to search on the Internet and locate the required study materials as per advise of the teacher.

P.T.O

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Promote positive health, get relief from stress and obtain balance of body & mind.
CO2	Acquire knowledge of integral approach of Yoga Therapy to common ailments.
CO3	Develop skills to adopt Yoga practices for health and general well-being.
CO4	Develop overall personality through control of body, mind and soul.
CO5	Enhance scientific attitude and team spirit for creative and constructive endeavors.

**Program Outcomes Relevant to the Course:**

PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1		1	3			2		1	2
CO2						1			1			2		1	2
CO3						2			1			2		1	2
CO4								2	3			1		2	3
CO5						2		2	2			1		2	3

Type	Code	Math-IV for ECE/EEE/EIE	L-T-P	Credits	Marks
BS	18BS1T04		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to provide the knowledge of vector calculus, partial differential equations & numerical methods, along with the applications of these methods in engineering.
<b>Pre-Requisites</b>	Knowledge of calculus of single variable, coordinate geometry of two and three dimensions, and ordinary differential equations is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Partial derivatives, Chain rule Maxima minima in several variables; Vector and scalar functions and fields, derivatives, Directional derivative & gradient of a scalar field, Divergence & Curl of a vector field.	<b>8 Hours</b>
<b>Module-2</b>	Vector line integrals, Line integrals independent of path, Double integrals, Green's theorem in the plane Surfaces, Surface integrals, Triple integrals, Gauss divergence theorem, Stoke's theorem.	<b>10 Hours</b>
<b>Module-3</b>	Basic Concepts of PDEs, One Dimensional Wave Equation and its solutions, One Dimensional Heat Equation and its solutions, Two dimensional heat equation, Laplace Equation, Solution of Laplace equation in cylindrical and spherical coordinates.	<b>10 Hours</b>
<b>Module-4</b>	Error Analysis, Solution of Nonlinear Equations, Bisection Method, Fixed-Point Iteration Method, Secant Method, Newton Method, Interpolation by Polynomials: Lagrange Interpolation, Newton Divided Differences, Newton's forward & backward Interpolation.	<b>7 Hours</b>
<b>Module-5</b>	Numerical Differentiation and Integration, Trapezoidal, Simpson's Rules, Composite Rules, Error Formulae, Gaussian Quadrature Rules, Solution of Differential Equations by Euler Method, Modified Euler Method, and Runge-Kutta Methods.	<b>7 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

T1. E. Kreyszig, *Advanced Engineering Mathematics*, 8<sup>th</sup> Edition, Wiley India, 2015.

#### Reference Books:

R1. S. Pal and S. C. Bhunia, *Engineering Mathematics*, 1<sup>st</sup> Edition, Oxford University Press, 2015.

R2. B. V. Ramana, *Higher Engineering Mathematics*, 1<sup>st</sup> Edition, McGraw-Hill, 2017.

#### Online Resources:

1. <http://www.nptel.ac.in/courses/111105035>
2. <http://www.nptel.ac.in/courses/122104017>
3. <http://nptel.ac.in/courses/122102009>

4. <http://nptel.ac.in/courses/111107063>
5. <https://www.coursera.org/learn/linearalgebra2>
6. <https://www.coursera.org/learn/differentiation-calculus>
7. <https://www.coursera.org/learn/single-variable-calculus>
8. <https://alison.com/courses/Algebra-Functions-Expressions-and-Equations>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand the concepts vector differential calculus and their applications.
CO2	Understand the concepts vector integral calculus and their applications.
CO3	Solve partial differential equations for engineering applications and interpret the solution.
CO4	Find the root of non-linear and transcendental equations using numerical methods and interpolate a data.
CO5	Perform numerical integration and solve ordinary differential equations using various numerical methods.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	1								2	1	1
CO2	3	3	2	1	2								3	1	1
CO3	3	3	3	3	1								2	1	1
CO4	3	3	3	2	3								3	1	1
CO5	3	3	2	2	2								3	1	1

Type	Code	Basics of Mechanical Engineering	L-T-P	Credits	Marks
ES	18ES1T08		3-1-0	4	100

<b>Objectives</b>	The objectives of this course are to provide an introductory treatment of Mechanical Engineering with working knowledge of engineering mechanics and concepts of thermodynamics to enable the students understand implications of mechanics and thermodynamics in their stream of engineering.
<b>Pre-Requisites</b>	Basic analytical and logical skills, a working knowledge of Physics and Mathematics including introductory calculus are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Basic concepts of Thermodynamics and Pure Substances:</b> Introduction, basic concepts and definitions - System, Control Volume, Surrounding, Boundaries, Types of Systems, Macroscopic and Microscopic approaches, Thermodynamic Equilibrium, State, Property, Process, Exact & Inexact Differentials, Point and Path functions, Cycle – Reversibility and Irreversibility, Zeroth Law of Thermodynamics as the basis for Temperature Measurement – Principles of Thermometry, Types of Thermometers, Constant Volume gas Thermometer; Definition of pure substance, p-v, T-v, T-s and h-s diagrams for water, Triple point and critical state, properties during change of phase, Dryness Fraction, Property tables. Ideal Gas Law, Equations of State.	<b>12 Hours</b>
<b>Module-2</b>	<b>First and Second Laws of Thermodynamics:</b> Joule's Experiments – First law of Thermodynamics, PMM1, First law applied to a Closed System, Steady Flow Energy Equation (SFEE) with examples such as Nozzle, Diffuser, Throttling devices, Turbine and Compressor; Kelvin-Planck and Clausius Statements; Corollaries, PMM2, Carnot's principle, Carnot cycle and the Thermodynamic Temperature Scale, Clausius Inequality, Entropy, Principle of Entropy Increase; Heat Engine Cycle (Steam Power Plant) and Refrigeration Cycle, Calculation of COP.	<b>12 Hours</b>
<b>Module-3</b>	<b>Engineering Mechanics:</b> Basic concepts, System of Forces, Coplanar Concurrent Forces, Resultant-Moment of Forces and its Applications; Couples, Moment (about point and about axis), Varignon's theorem, Resultant of concurrent and non-concurrent coplanar forces, Static equilibrium, Free body diagram, Reactions; Basic concept of pulleys, Friction, Laws of Coulomb friction; Problems involving large and small contact surfaces (Ladder and Wedges.)	<b>12 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-4	<b>Center of Gravity &amp; Moments of Inertia:</b> Centroid and Centre of Gravity, Centroid of simple figures from first principle, Centroid of composite sections; Centre of gravity and its implications; Theorems of Pappus and Guldinus, Area moment of inertia - Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, parallelepiped.	8 Hours
Module-5	<b>Kinematics of Rectilinear and Curvilinear Motion:</b> Differential equations of rectilinear motion, D' Alembert's Principle, Momentum and Impulse, Work & Energy, Conservation of energy, Impact; Normal and Tangential acceleration, Motion of a Projectile, Work and Energy in curvilinear motion.	12 Hours
<b>Total</b>		<b>56 Hours</b>

**Text Books:**

- T1. R. E. Sonntag, C. Borgnakke, and G. J. Van Wylen, *Fundamentals of Thermodynamics*, 9<sup>th</sup> Edition. John Wiley & Sons, 2017.
- T2. Y. A. Cengel and M. A. Boles, *Thermodynamics – An Engineering Approach*, 8<sup>th</sup> Edition, McGraw-Hill, 2017.
- T3. S. Timoshenko, D. H. Young, S. Pati, and J. V. Rao, *Engineering Mechanics*, 5<sup>th</sup> Edition, McGraw-Hill, 2013.

**Reference Books:**

- R1. P. K. Nag, *Engineering Thermodynamics*, 4<sup>th</sup> Edition, McGraw-Hill, 2008.
- R2. J. L. Meriam and L. G. Kraige, *Engineering Mechanics: Statics & Engineering Mechanics: Dynamics* (two books), 7<sup>th</sup> Edition, John Wiley & Sons. 2012.
- R3. S. S. Bhavikatti, *Engineering Mechanics*, 3<sup>rd</sup> Edition, New Age International, 2008.

**Online Resources:**

1. <https://nptel.ac.in/courses/112103108/>: Engineering Mechanics
2. <https://nptel.ac.in/courses/112105123/>: Basic Thermodynamics

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Become familiar with the terms used in thermodynamics and measurement of temperature, pressure and pure substances.
CO2	Acquire skills and knowledge to apply the first law of Thermodynamic to solve the problems related to steady flow devices and understand the concepts of second law of Thermodynamics.
CO3	Understand the principles of mechanics and analyze static systems to solve real life problems.
CO4	Realize concepts of centroid, center of gravity and distributed forces in a plane, determine the area and mass moments of inertia and apply them for basic structural design.
CO5	Acquire skills and knowledge to solve problems in dynamics for both rectilinear and curvilinear motion.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
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Cont'd...

PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	2	1								2		1
CO2	2	1	2	2	1								2		1
CO3	3	3	2	2	1								2		1
CO4	3	3	3	1	1								2		1
CO5	3	3	2	2	1								2		1



Type	Code	Engineering Economics	L-T-P	Credits	Marks
HS	18HS1T02		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to familiarize the students with elementary principles of economics, provide the tools needed for analyzing time value of money in engineering decision making, profit/revenue data, and make economic analysis for projects and alternatives.
<b>Pre-Requisites</b>	Basic knowledge on interest formula and derivatives is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with focus on real-world problem solving.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Engineering Economics-its meaning and importance, Basic problems of an economy. The concept of time value of money; Concept of Interest. Time value of equivalence, Compound interest factors; Cash flow diagrams, Calculation of time value of equivalence, Present worth comparison, Future worth comparison, Pay-back period comparison.	<b>9 Hours</b>
<b>Module-2</b>	Equivalent annual worth comparison method, Situations for equivalent annual worth comparison, Rate of return, Internal rate of return, Incremental IRR analysis, Depreciation analysis, Methods of depreciation, Straight line method, Declining balance method, SOYD Method and MACRS method of depreciation; After tax comparison, Analysis of public Project, Cost-benefit analysis.	<b>9 Hours</b>
<b>Module-3</b>	Introduction to Micro Economics and Macro Economics, Theory of demand, Elasticity of demand, Price elasticity of demand, Measurement of elasticity of demand; Income elasticity and cross elasticity of demand, Demand forecasting; Law of supply, Elasticity of supply.	<b>8 Hours</b>
<b>Module-4</b>	Theory of production, Law of variable proportion, Laws of returns to scale, Cost Concepts, Total Costs, Fixed cost, Variable cost, Revenue concepts, Total revenue, Average revenue and marginal revenue, Market (Forms of market), Perfect Competition, Determination of price under perfect competition, Linear Break-even Analysis.	<b>8 Hours</b>
<b>Module-5</b>	Inflation, Meaning of inflation, Types, Causes, Measures to control inflation, Commercial Banks, Functions of Commercial Bank, Central bank, Functions of central Bank; National income, Definitions, Concepts of national Income, Methods of measuring National Income.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. J. L. Riggs, D. D. Bedworth, and S. U. Randhawa, *Engineering Economics*, 4<sup>th</sup> Edition, Tata McGraw-Hill, 2004.

- T2. H. L. Ahuja, *Principles of Micro Economics*, 16<sup>th</sup> Edition, S. Chand & Co, 2008.  
 T3. R. R. Paul, *Monetary Economics*, 11<sup>th</sup> Edition, Kalyani Publishers, 2015.

#### Reference Books:

- R1. C. S. Park, *Contemporary Engineering Economics*, 6<sup>th</sup> Edition, Pearson Education, 2015.  
 R2. D. G. Newnan, T. G. Eschenbach, J. P. Lavelle, and N. A. Lewis, *Engineering Economic Analysis*, 13<sup>th</sup> Edition, Oxford University Press, 2017.  
 R3. A. Koutsoyiannis, *Modern Micro Economics*, 2<sup>nd</sup> Edition, Palgrave Macmillan UK, 2003.  
 R4. H. C. Petersen, W. C. Lewis, and S. K. Jain, *Managerial Economics*, 4<sup>th</sup> Edition, Pearson, 2005.  
 R5. N. G. Mankiw, *Macroeconomics*, 7<sup>th</sup> Edition, Worth Publishers, 2010.  
 R6. M. P. Agasty, *Engineering Economics and Costing*, 2<sup>nd</sup> Edition, Scitech Publication, 2009.

#### Online Resources:

1. <https://nptel.ac.in/courses/112107209/>: Engineering Economic Analysis
2. [https://www.icaai.org/post.html?post\\_id=10058](https://www.icaai.org/post.html?post_id=10058): Study Materials by ICAI
3. <http://www.icaiknowledgegateway.org/littledms/folder1/chapter-5-part-2.pdf>: National Income Accounting
4. <http://www.m5zn.com/newuploads/2013/05/28/pdf/ed6f3d1f87b9cd2.pdf>: eBook

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand the concepts of economics, engineering economics and its application in engineering.
CO2	Solve problems related to engineering economics and analyze decision alternatives in engineering projects.
CO3	Evaluate how changes in demand and supply affect market and production.
CO4	Assess the effects of changes in costs, selling price and units sold on the break-even point and target profit.
CO5	Analyze the macroeconomic environment of the business and its impact on society and enterprise.

#### Program Outcomes Relevant to the Course:

PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1			1		3	1		1	2
CO2						1			1		3	1		1	3
CO3						2	2				3	1		1	2
CO4						2	2		1		3	1		1	3
CO5						2	2		1		3			2	2

Type	Code	Microprocessors & Microcontrollers	L-T-P	Credits	Marks
PC	18EC1T04		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to be familiar about different microprocessors & microcontrollers, be able to develop assembly level programs as per user / industry requirements, and interface with other external devices.
<b>Pre-Requisites</b>	Basic knowledge of Digital Electronics Circuit is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on theory and programming activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction to Microprocessors:</b> Overview of microcomputer systems and their building blocks(Architecture, Configuration), memory organization, memory interfacing, Timing Diagram, concepts of interrupts and Direct Memory Access, Programming skills with the help of instruction sets of microprocessors (with examples of 8085 and 8086 - minimum and maximum mode of operation).	<b>8 Hours</b>
<b>Module-2</b>	<b>Interfacing with Peripherals:</b> Microprocessor interface with timer, serial I/O, parallel I/O, A/D and D/A converters; Arithmetic Co-processors; System level interfacing design with various ICs like 8255, 8259, 8237, 8251, 8279.	<b>8 Hours</b>
<b>Module-3</b>	<b>Concepts of Virtual Memory:</b> Cache memory, Advanced Co-processor Architectures – 286, 486, Pentium;	<b>8 Hours</b>
<b>Module-4</b>	<b>Microcontrollers:</b> 8051 systems – Introduction to 8051 Microcontrollers, Architecture, Memory Organization, Special Function Register, Port Operation, Memory Interfacing, I/O Interfacing, Programming 8051 using various types of instructions like Arithmetic, Logical, Data Transfer etc., Interrupts, Operand types, Operand addressing.	<b>10 Hours</b>
<b>Module-5</b>	<b>Introduction to RISC Processors:</b> ARM microcontrollers interface designs; Simple programming exercise – Keyboard and Display interface, Closed Loop control of Servo motor – stepper motor control, washing machine control.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. R. S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*, 6<sup>th</sup> Edition, Penram International Publishing, 2013.
- T2. D. A. Patterson and J. H. Hennessy, *Computer Organization and Design: The Hardware/Software Interface*, 5<sup>th</sup> Edition, Morgan Kaufman Publishers, 2013.

#### Reference Books:

- R1. D. Hall, *Microprocessors and Interfacing*, 3<sup>rd</sup> Edition, McGraw-Hill Education, 2017.

- R2. K. J. Ayala, *The 8051 Microcontroller*, 3<sup>rd</sup> Edition, Cengage Learning, 2007.  
 R3. K. Kant, *Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096*, 2<sup>nd</sup> Edition, Prentice Hall India, 2013.

#### Online Resources:

1. <https://nptel.ac.in/courses/108107029/>: by Dr. P. Agarwal, IIT Roorkee
2. <https://nptel.ac.in/courses/106108100/>: by Prof. Krishna Kumar IISc Bangalore
3. <http://www.electrical4u.com/circuit-analysis.htm>
4. <http://www.allaboutcircuits.com>
5. <https://www.electronics-tutorials.ws/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the architecture & functionality of Microprocessors, develop programs to perform data transfer, arithmetic & logical tasks, and understand modes of operation & memory management.
CO2	Interface external devices to the processor like 8255 PPI, 8251 USART, 8279 Key Board/display according to user requirements to create products and solutions for real life applications.
CO3	Explain the concept of virtual memory and co-processor architecture in different processors.
CO4	Differentiate the functionality of microprocessor and microcontrollers and program a microcontroller to perform tasks according to the requirements.
CO5	Design, formulate and implement microprocessor and microcontroller based systems using ARM and state of the art tools.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1								3		
CO2	3	3	2	3	3							1	3		
CO3	3	3	2	2	3								3		
CO4	3	3	2	2	2							1	3		
CO5	2	2	3	2	3				2	2			2		

Type	Code	Analog Electronic Circuits	L-T-P	Credits	Marks
PC	18EI1T01		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to be familiar with Transistors (BJT, JFET and MOSFET) amplifiers, differential amplifiers and their implementations, and also study their characteristics and applications.
<b>Pre-Requisites</b>	Basic knowledge of semiconductor diodes and Bipolar Junction Transistors (BJT) is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Bipolar Junction Transistor (BJT):</b> Construction and V-I Characteristics of BJT, Operation (CB, CE and CC Configurations), relation between the current gain, BJT Biasing, Bias Stability, Design of different Biasing Techniques, Operating point.	<b>9 Hours</b>
<b>Module-2</b>	<b>Field Effect Transistor (FET):</b> Construction, V-I Characteristics of Junction FET (JFET), JFET Biasing (Fixed, Self and Voltage divider); MOSFET Circuits: Construction, Characteristics of Depletion and Enhancement type Metal Oxide Semiconductor Field Effect Transistor (MOSFETs), MOSFET as a switch, MOSFET as an amplifier, Introduction to CMOS circuits.	<b>9 Hours</b>
<b>Module-3</b>	<b>AC Analysis of Amplifiers:</b> BJT small signal model, Transistor re model and Hybrid Model of CB, CE and CC configuration, Effect of $R_L$ and $R_S$ , Darlington pair; JFET small signal model, Fixed bias, Self bias, voltage divider bias, common gate, source follower, effect of $R_L$ and $R_S$ , Current Mirror, Cascade & Cascode configuration; Frequency Response of BJT and FET, Miller Effect Capacitance, Multistage Frequency Effects.	<b>10 Hours</b>
<b>Module-4</b>	<b>Operational Amplifiers:</b> Differential amplifier, CMRR, Ideal op-amp and its characteristics; Inverting and non-inverting amplifier, integrator, differentiator, differential amplifier, instrumentation amplifier, active filter.	<b>7 Hours</b>
<b>Module-5</b>	<b>Feedback Amplifiers:</b> Concepts of feedback, General characteristics of negative feedback amplifiers, Topology, simple problems on practical negative feedback amplifiers, Condition for oscillations; RC-phase shift, Wien-bridge and Crystal oscillators.	<b>7 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

1. A. S. Sedra and K. C. Smith, *Microelectronic Circuits: Theory and Applications (International Version)*, 6<sup>th</sup> Edition, Oxford University Press, 2013.
2. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 10<sup>th</sup> Edition, Pearson Education, 2009.

- T3. J. V. Wait, L. P. Huelsman, and G. A. Korn, *Introduction to Operational Amplifier Theory and Applications*, McGraw-Hill USA, 1992.
- T4. J. Millman and A. Grabel, *Microelectronics*, 2<sup>nd</sup> Edition, McGraw-Hill Education, 2017.

#### Reference Books:

- R1. J. Millman and C. C. Halkias, *Integrated Electronics: Analog and Digital Circuits and Systems*, 2<sup>nd</sup> Edition, TMH Publications, 2017.
- R2. A. Malvino and D. J. Bates, *Electronic Principles*, 7<sup>th</sup> Edition, McGraw-Hill, 2017.
- R3. P. Horowitz and W. Hill, *The Art of Electronics*, 2<sup>nd</sup> Edition, Cambridge University Press, 1989.
- R4. P. R. Gray, P. J. Hurst, R. G. Meyer, and S. H. Lewis, *Analysis and Design of Analog Integrated Circuits*, 5<sup>th</sup> Edition, John Wiley & Sons, 2009.

#### Online Resources:

1. <https://nptel.ac.in/courses/117101106/>
2. <https://nptel.ac.in/courses/108102095/>
3. <http://www.electrical4u.com/circuit-analysis.htm>
4. <http://www.allaboutcircuits.com>
5. <https://www.electronics-tutorials.ws/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand and analyze the structural configuration, different biasing methods of BJT.
CO2	Analyze the structural behavior, characteristics and different biasing configurations of JFET and MOSFET.
CO3	Design small signal models and estimate the performance parameters of different amplifier configurations required for the industry.
CO4	Study the construction and characteristics of an Op-Amp and design circuits for various linear applications using Op-Amp.
CO5	Design various industrial circuits such as oscillators & negative feedback amplifiers using transistors and validate their experimental results.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3								2		
CO2	3	3	3	3	2								2		
CO3	3	3	2	3	2								3		
CO4	3	3	3	2	3							1	3		1
CO5	3	3	3	3	3							1	3		1

Type	Code	Measurements & Instrumentation	L-T-P	Credits	Marks
PC	18EE1T02		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to introduce the students to basic principle of operation of different electrical & electronic measuring instruments and their uses in different branches of engineering. The course will also introduce the applications of transducers, storage, display and data acquisition systems.
<b>Pre-Requisites</b>	Basic knowledge of intermediate physics, Mathematics, Basic Electrical Engineering and Basic Electronics Engineering is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Types of Measurement Systems, Accuracy and Precision, Types of Errors, Standards and calibration, Classification of Measuring instruments. <b>Electromechanical Indicating type Instruments:</b> Types of torque, general constructional details. <b>Ammeter and Voltmeter:</b> Derivation for Deflecting Torque of PMMC, MI, Electro Dynamometer and Induction type. <b>Measurement of Power, Energy and Frequency:</b> Construction, Theory and Principle of operation of (a) Electro-Dynamometer and Induction type Wattmeter (b) Single Phase Induction Type Watt-hour meter (c) Frequency Meter.	<b>10 Hours</b>
<b>Module-2</b>	<b>Measurement of Resistance:</b> Measurement of Resistance of Insulating Materials, Measurement of Resistance of Earth Connections. <b>Measurement of Inductance:</b> Maxwell's, Hay's, Anderson Bridge, Measurement of Mutual-Inductance by Felici's method. <b>Measurement of Capacitance:</b> Wein's, Owen's and Schering Bridge. Wagner's earthing device.	<b>8 Hours</b>
<b>Module-3</b>	<b>Potentiometer:</b> DC Potentiometers (Crompton), AC Potentiometers (Drysdale-Tinsley). <b>Instrument Transformers:</b> Construction, Theory, Equivalent circuit, Phasor Diagram, and characteristics of CTs and PTs.	<b>8 Hours</b>
<b>Module-4</b>	<b>Electronic Instruments:</b> Digital voltmeters, Ammeters, Multimeters, AC Voltmeters using Rectifiers. <b>Storage and Display Devices:</b> Magnetic disk and tape recorders, Digital plotters and printers, CRT display, Digital CRO, LED, LCD & dot matrix display, Data loggers.	<b>8 Hours</b>
<b>Module-5</b>	<b>Transducers and Data Acquisition Systems:</b> Classification of transducers, Selection of transducers, Resistive, Capacitive & Inductive transducers, Piezoelectric, Hall effect, Optical and digital transducers, Elements of data acquisition system, A/D and D/A converters, Smart sensors.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

P.T.O

**Text Books:**

- T1. E. W. Golding and F. C. Widdis, *Electrical Measurements and Measuring Instruments*, 5<sup>th</sup> Edition, Reem Publication, 2015.
- T2. A. K. Sawhney, *A Course in Electrical and Electronics Measurement and Instrumentation*, 19<sup>th</sup> Edition, 2011.
- T3. R. K. Rajput, *Electrical and Electronic Measurement and Instrumentation*, S. Chand & Co, 2016.

**Reference Books:**

- R1. D. A. Bell, *Electronic Instrumentation and Measurements*, 3<sup>rd</sup> Edition, Oxford University Press, 2013.
- R2. A. D. Helfrick and W. D. Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, 1<sup>st</sup> Edition, Pearson Education, 2015.
- R3. J. B. Gupta, *A Course in Electrical and Electronic Measurements & Instrumentation*, S. K. Kataria & Sons, 2013..

**Online Resources:**

1. <https://www.youtube.com/watch?v=11cWFio3h4U>
2. <https://nptel.ac.in/syllabus/108106070/>
3. <http://www.npl.co.uk/upload/pdf/beginners-guide-to-measurement-in-electronic-and-electrical-engineering.pdf>
4. [http://lrf.fe.uni-lj.si/fkkt\\_ev/Literatura/Electrical.and.Electronics.Measurment.pdf](http://lrf.fe.uni-lj.si/fkkt_ev/Literatura/Electrical.and.Electronics.Measurment.pdf)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Identify the instrument suitable for accurate and precise measurement of current, voltage, power and energy with their construction, theory and operating principle.
CO2	Estimate accurately the values of R, L and C employing suitable bridges.
CO3	Understand the construction, theory and working of Potentiometers and Instrument Transformers and their application.
CO4	Learn the working principle of various electronics instruments, storage and display devices.
CO5	Understand the working of various transducers and data acquisition systems.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1									1		
CO2	2	1	1	2									1		
CO3	2	1	1	2									1		
CO4	2	2	1										2		
CO5	1	2	2	2	1								1		1

Type	Code	Microprocessors & Microcontrollers Lab	L-T-P	Credits	Marks
PC	18EC1L02		0-0-2	1	100

<b>Objectives</b>	The objective of the course is to provide hands-on practice on programming of different microprocessors and microcontrollers and their interfacing with external devices.
<b>Pre-Requisites</b>	Basic analytical & logical understanding including basic knowledge and usage of Digital Electronics is required.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted using hardware and software tools under the supervision of the teacher; the experiments shall consist of programming assignments.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Programs for 16 bit arithmetic operations using 8086.
2	Programs for Sorting and Searching (using 8086).
3	Programs for String manipulation operations (using 8086).
4	Programs for Digital clock and Stop watch (using 8086).
5	Interfacing ADC and DAC.
6	Parallel Communication between two MP Kits using Mode 1 and Mode 2 of 8255.
7	Interfacing and Programming 8279, 8259, and 8253.
8	Serial Communication between two MP Kits using 8251.
9	Interfacing and Programming of Stepper Motor and DC Motor Speed control.
10	Programming using Arithmetic, Logical and Bit Manipulation instructions of 8051 microcontroller.
11	Programming and verifying Timer, Interrupts and UART operations in 8051 microcontroller.
12	Communication between 8051 Microcontroller kit and PC.
13, 14	A design problem using 8051 (such as, multi-parameter data acquisition system, voltmeter, power meter, frequency counter, traffic simulation, digital clock, etc.)

#### Text Books:

- T1. R. S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*, 6<sup>th</sup> Edition, Penram International Publishing, 2013.
- T2. D. A. Patterson and J. H. Hennessy, *Computer Organization and Design: The Hardware/Software Interface*, 5<sup>th</sup> Edition, Morgan Kaufman Publishers, 2013.

#### Reference Books:

- R1. D. Hall, *Microprocessors and Interfacing*, 3<sup>rd</sup> Edition, McGraw-Hill Education, 2017.
- R2. K. J. Ayala, *The 8051 Microcontroller*, 3<sup>rd</sup> Edition, Cengage Learning, 2007.
- R3. K. Kant, *Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096*, 2<sup>nd</sup> Edition, Prentice Hall India, 2013.

**Online Resources:**

1. <https://nptel.ac.in/courses/108105102/7>
2. <https://nptel.ac.in/courses/108107029/>
3. <https://nptel.ac.in/courses/108105102/38>
4. <http://www.electrical4u.com/circuit-analysis.htm>
5. <http://www.allaboutcircuits.com>
6. <https://www.electronics-tutorials.ws/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Express the fundamentals of evolution, operating concept, and assembly language programming & instruction sets of 8086 Microprocessor.
CO2	Develop and apply assembly language programs using loop, branch, arithmetic, logical, shift, rotate, array & String operations.
CO3	Formulate programs like finding largest/smallest numbers, check existence of data, etc.
CO4	Experiment with assembly level programming of 8051 microcontroller & its functions for various applications.
CO5	Analyze modes of operation of 8255 PPI and peripheral interfacing using A/D and D/A converter, Stepper motor controller, and keyboard with display interface using 8279 PIC.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1							2	1	
CO2	3	2	3	2	2							1	3		
CO3	3	2	3	2	3								3		
CO4	3	2	3	3	3							1	3		
CO5	3	2	2	2	2							1	2		

Type	Code	Analog Electronic Circuits Lab	L-T-P	Credits	Marks
PC	18EI1L01			0-0-2	1

<b>Objectives</b>	The objective of the course is to design, implement and testing of transistor biasing, amplifying action and frequency response. Also study the linear and nonlinear applications of amplifiers.
<b>Pre-Requisites</b>	Basic analytical and logical understanding including basic knowledge of Basic electronics is required.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted under supervision of the teacher with focus on implementation in hardware/software tools.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Design and simulate BJT bias circuit and compare the results.
2	Design and simulate JEET/MOSFET bias circuit and compare the results.
3	Design and simulate BJT common-emitter circuit and compare DC and AC performance.
4	Design and simulate JFET/MOSFET common-source circuit and compare DC and AC performance.
5	Determining the frequency response of a common-emitter amplifier: low frequency, high frequency and mid frequency response and compare with simulated results.
6	Differential amplifiers circuits: DC bias and AC operation without and with current source.
7	Study of Darlington connection and current mirror circuits.
8	OP-Amp Frequency Response and Compensation.
9	Application of Op-Amp as differentiator, integrator, square wave generator.
10	Obtain the band width of FET/BJT using Square wave testing of an amplifier.
11	RC phase shift oscillator/Wien-Bridge Oscillator using Op-Amp/Crystal Oscillator.
12	Class A and Class B Power Amplifiers.

#### Text Books:

- T1. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 10<sup>th</sup> Edition, Pearson Education, 2009.

#### Reference Books:

- R1. L. K. Maheshwari and M. M. S. Anand, *Laboratory Experiments and PSPICE Simulations in Analog Electronics*, PHI Learning, 2006.  
 R2. L. K. Maheshwari and M. M. S. Anand, *Laboratory Manual for Introductory Electronics Experiments*, John Wiley & Sons, 1980.  
 R3. K. A. Navas, *Electronics Lab Manual, Vol-2*, 6<sup>th</sup> Edition, PHI Learning, 2018.

**Online Resources:**

1. <http://www2.ece.ohio-state.edu/ee327/>
2. [https://wiki.analog.com/university/courses/alm1k/alm\\_circuits\\_lab\\_outline](https://wiki.analog.com/university/courses/alm1k/alm_circuits_lab_outline)
3. <https://wiki.analog.com/university/courses/electronics/labs>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Design, assemble and test BJT biasing circuits.
CO2	Analyze the Dc and Ac performance of BJT and FET.
CO3	Understand the frequency response of single & multi-stage BJT and compare the results.
CO4	Study operational amplifier and its various applications.
CO5	Analyze and design various wave shaping circuits.
CO6	Implement different oscillator circuits and analyze power amplifier characteristics.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2							1	2	1	1
CO2	3	3	2	3	2								2	1	
CO3	3	3	2	3	3								2	1	
CO4	3	3	3	3	3								2	1	
CO5	3	2	2	3	2							1	2	1	1
CO6	3	2	3	3	3								2	1	



Type	Code	Measurements & Instrumentation Lab	L-T-P	Credits	Marks
PC	18EE1L02		0-0-2	1	100

<b>Objectives</b>	The objective of the course is to cover the constructional features, working principle, testing, and calibration of different measuring instruments and provide an overview of various measuring techniques.
<b>Pre-Requisites</b>	Basic knowledge of different electrical components and different analysis techniques of electrical and magnetic circuits. Topics taught in EEM theory class are essential to conduct the experiments.
<b>Teaching Scheme</b>	Regular laboratory experiments conducted under supervision of the teacher. Demonstration along with associated safety measures will also be explained.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Measurement of Low Resistance using Kelvin's Double Bridge.
2	Measurement of Self Inductance using Anderson's Bridge.
3	Measurement of capacitance using Schering Bridge.
4	Calibration of Voltmeters and Ammeters using Crompton's Potentiometer.
5	Testing of Energy meters (Single phase type).
6	Study of hysteresis loop using CRO.
7	Measurement of R, L, and C using Q-meter.
8	Measurement of Power in a single phase circuit using CT and PT.
9	Measurement of Power and Power Factor in a three phase AC circuit by two-wattmeter method.
10	Study of Lissajous pattern using CRO and measurement of unknown frequency.
11	Measurement of Iron Loss from B-H Curve by using CRO.
12	Measurement of Self-Inductance using Ammeter-Voltmeter method.
13	Study of Spectrum Analyzer.

#### Text Books:

- T1. E. W. Golding and F. C. Widdis, *Electrical Measurements and Measuring Instruments*, 5<sup>th</sup> Edition, Reem Publication (Selected portions from Ch. V, VI, VII, VIII, IX, XVII, XVIII), 2015.
- T2. A. K. Sawhney, *A Course in Electrical and Electronics Measurement and Instrumentation*, 19<sup>th</sup> Edition (Selected portions from Chapter 2, 3, 10, 11, 12, 13, 15, 20, 22, 23, 24, 33), 2011.
- T3. R. K. Rajput, *Electrical and Electronic Measurement and Instrumentation*, S Chand & Co, 2016.

#### Reference Books:

- R1. D. A. Bell, *Electronic Instrumentation and Measurements*, 3<sup>rd</sup> Edition, Oxford University Press, 2013.
- R2. A. D. Helfrick and W. D. Cooper, *Modern Electronic Instrumentation and Measurement Techniques*, 1<sup>st</sup> Edition, Pearson Education (Selected portions from Ch. 1, 3, 6, 7, 9, 10, and 13), 2015.

**Online Resources:**

1. <https://www.youtube.com/watch?v=11cWFio3h4U>
2. <https://nptel.ac.in/syllabus/108106070/>
3. <http://www.npl.co.uk/upload/pdf/beginners-guide-to-measurement-in-electronic-and-electrical-engineering.pdf>
4. [http://lrf.fe.uni-lj.si/fkkt\\_ev/Literatura/Electrical\\_and\\_Electronics\\_Measurment.pdf](http://lrf.fe.uni-lj.si/fkkt_ev/Literatura/Electrical_and_Electronics_Measurment.pdf)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Estimate accurately the values of R, L and C employing suitable bridges.
CO2	Measure power and energy with suitable measuring instruments.
CO3	Learn about different types of electronic instruments.
CO4	Calibrate different measuring instruments.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1					1				1		
CO2	2	1	2	2					1				1	1	
CO3	2	2	2	2					1				2		
CO4	1	1	1						1				1		1

**Part III**  
**3rd Year B. Tech. (ECE)**

## Curriculum Structure

Semester V								
Type	Code	Course Title	WCH L-T-P			Credits L-T-P		
<b>THEORY</b>								
PC	18EC1T05	Analog Communication	3	0	0	3	0	0
PC	18EC1T06	Electromagnetic Waves	3	0	0	3	0	0
PC	18EE1T03	Control Systems Engineering	3	0	0	3	0	0
PC	18EC1T07	Signals & Systems	3	0	0	3	0	0
PE	18**2T**	Professional Elective - I	3	0	0	3	0	0
OE	18**3T**	Open Elective - I	3	0	0	3	0	0
<b>PRACTICAL</b>								
PC	18EC1L05	Analog Communication Lab	0	0	2	0	0	1
PC	18EC1L06	Electromagnetic Waves Lab	0	0	2	0	0	1
PC	18EE1L03	Control Systems Engineering Lab	0	0	2	0	0	1
HS	18HS1L02	Soft Skills & Inter-Personal Skills Lab	0	0	4	0	0	2
PJ	18IR6L02	Summer Internship-II	0	0	0	0	0	1
<b>SUB-TOTAL</b>			<b>18</b>	<b>0</b>	<b>10</b>	<b>18</b>	<b>0</b>	<b>6</b>
<b>TOTAL</b>			<b>28</b>			<b>24</b>		

Semester VI								
Type	Code	Course Title	WCH L-T-P			Credits L-T-P		
<b>THEORY</b>								
PC	18EI1T03	Digital VLSI Design	3	1	0	3	1	0
PC	18EC1T08	Digital Signal Processing	3	0	0	3	0	0
PE	18**2T**	Professional Elective - II	3	0	0	3	0	0
OE	18**3T**	Open Elective - II	3	0	0	3	0	0
BS	18BS1T11	Biology for Engineers	3	0	0	3	0	0
MC	18NC1T03	Professional Ethics & Values	2	0	0	0	0	0
<b>PRACTICAL</b>								
PC	18EI1L03	Digital VLSI Design Lab	0	0	2	0	0	1
PC	18EC1L08	Digital Signal Processing Lab	0	0	2	0	0	1
PJ	18EC6L03	Skill Lab & Project - I	0	0	4	0	0	2
<b>SUB-TOTAL</b>			<b>17</b>	<b>1</b>	<b>8</b>	<b>15</b>	<b>1</b>	<b>4</b>
<b>TOTAL</b>			<b>26</b>			<b>20</b>		

Note: Courses offered under each elective are given in "List of Electives" on Page 102.

### List of Electives

Code	Elective # and Subjects
<i>Professional Elective - I</i>	
18EI2T47	MEMS & Sensor Design
18EE2T54	Power Electronics
18EE2T14	Soft Computing Techniques
<i>Professional Elective - II</i>	
18EC2T45	Information Theory & Coding
18EC2T56	Robotics & Robot Applications
18EI2T09	IoT & Applications
<i>Open Elective - I</i>	
18EE3T26	[EEE] Basics of Power Systems
18BS3T01	[BSH] Applied Linear Algebra
18BS3T02	[BSH] Fluid Mechanics
18CS3T04	[CSE] Fundamentals of DBMS
18EI3T43	[EIE] Transducers & Measurement Systems
<i>Open Elective - II</i>	
18EE3T39	[EEE] Power Station Engineering
18BS3T06	[BSH] Numerical Optimization
18BS3T07	[BSH] Organizational Behaviour
18CS3T09	[CSE] Operating Systems
18CS3T10	[CSE] Programming in Python
18EI3T11	[EIE] Industrial Automation & Control

Note: *Open Electives* are choice-based courses offered by other departments as indicated within brackets.

Type	Code	Analog Communication	L-T-P	Credits	Marks
PC	18EC1T05			3-0-0	3

<b>Objectives</b>	The objective of this course is to study analog communication systems, different modulation techniques, digital transmission of analog signals, and sources & suppression of noise in transmission.
<b>Pre-Requisites</b>	Basic knowledge of signals and systems, trigonometry, and probability theory is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Signals and Spectra:</b> Overview of Electronic Communication Systems, Types of Signal, Fourier Series, Fourier Transform, Properties of Fourier Transform, Orthogonal Signal.	<b>8 Hours</b>
<b>Module-2</b>	<b>Amplitude Modulation:</b> Need for frequency translation, Double Side Band with Carrier (DSB-C) and Suppressed Carrier (DSB-SC), Modulators - Square-law, Switching, Balanced, Detectors - Square-law, Envelope, Synchronous, Single Side Band with Suppressed Carrier (SSB-SC), Frequency & Phase discrimination methods, Coherent detection, Modulation & demodulation of Vestigial Side Band Modulation (VSB), Frequency Division Multiplexing, Radio Transmitter and Receiver (Super Heterodyne Receiver).	<b>9 Hours</b>
<b>Module-3</b>	<b>Angle Modulation:</b> Angle Modulation, Narrow & Wide band FM, FM Modulators - Direct method (Varactor diode), Indirect method (Armstrong), Detectors - Simple slope, Balanced Slope, Phase Locked Loop (PLL); <b>Pulse Modulation and Digital Transmission of Analog Signal:</b> Analog to Digital (Noisy Channel and Role of Repeater), Sampling Theorem, Modulation - Pulse Amplitude, Pulse Width, Pulse Position; Concept of Time Division Multiplexing, Digital Representation of Analog Signal, Pulse code modulation (PCM).	<b>8 Hours</b>
<b>Module-4</b>	<b>Random Variables and Processes:</b> Probability, Random variables, Useful Probability Density functions, Useful properties and certain application issues; <b>Mathematical Representation of Noise:</b> Sources of Noise, Frequency-domain representation, Superposition of Noises, Linear Filtering, Noise Bandwidth.	<b>8 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Noise in AM System:</b> Framework for Amplitude Demodulation, Calculation of Signal to Noise Ratio - SSB-SC, DSB-SC, DSB-C; Threshold effect in AM; <b>Noise in FM System:</b> An FM Receiving System, Calculation of Signal to Noise Ratio, Comparison of FM and AM, Pre-emphasis and De-emphasis and SNR improvement, Threshold in FM, The FM Demodulator using Feedback (FMFB).	9 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. H. Taub, D. L. Schilling, and G. Saha, *Principles of Communication Systems*, 4<sup>th</sup> Edition, McGraw-Hill Education, 2013.
- T2. R. P. Singh and S. D. Sapre, *Communication Systems: Analog and Digital*, 3<sup>rd</sup> Edition, McGraw-Hill Education, 2012.

**Reference Books:**

- R1. M. Salehi and J. G. Proakis, *Communication System Engineering*, 2<sup>nd</sup> Edition, PHI, 2002.
- R2. S. Haykin and M. Moher, *Communication Systems*, 5<sup>th</sup> Edition, John Wiley & Sons, 2009.
- R3. B. P. Lathi, Z. Ding, and H. M. Gupta, *Modern Digital and Analog Communication Systems*, 4<sup>th</sup> Edition, Oxford University Press, 2017.

**Online Resources:**

1. <https://nptel.ac.in/courses/117/105/117105143/>: by Prof. G. Das, IIT Kharagpur
2. [https://nptel.ac.in/content/storage2/nptel\\_data3/html/mhrd/ict/text/117105143/lec60.pdf](https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/117105143/lec60.pdf)
3. <http://www.digimat.in/nptel/courses/video/117105143/L22.html>
4. <http://www.nptelvideos.in/2012/11/communication-engineering.html>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain different types of signals and their characteristics using Fourier analysis tools.
CO2	Describe the fundamental concepts of amplitude modulation and demodulation.
CO3	Articulate different types of modulation schemes and digital transmission of analog signals.
CO4	Realize the behavior of random variables, noise signal in frequency domain and linear filtering of noise.
CO5	Analyze the performance of AM and FM systems in presence of noise signals.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

*Cont'd...*

PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1							1	2		1
CO2	3	3	1	1	1							1	2		1
CO3	3	3	1	1	1							1	3		1
CO4	3	3	1	3	3								3		
CO5	3	2	3	3	3	1	1						3	1	



Type	Code	Electromagnetic Waves	L-T-P	Credits	Marks
PC	18EC1T06		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the fundamentals of electromagnetic waves including coordinate systems, vector calculus, electrostatic fields, magnetostatic fields, Maxwell's Equations, electromagnetic wave propagation, transmission lines and wave guides.
<b>Pre-Requisites</b>	Basic knowledge of coordinate systems, vector calculus, electric & magnetic fields and related laws is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Coordinate System &amp; Vector Calculus:</b> Cartesian, Cylindrical and Spherical Coordinate Systems; Scalar and Vector Fields; Line, Surface and Volume Integrals; <b>Electrostatic Fields:</b> Coulomb's Law, the Electric Field Intensity, Electric Flux Density and Electric Flux, Gauss's Law, Divergence of Electric Flux Density, The Divergence Theorem, Potential Gradient, Poisson's and Laplace's Equations; <b>Magneto-static Fields:</b> Ampere's Magnetic Circuital Law and its applications, Curl of H, Stokes' Theorem, Magnetic flux density B, Divergence of B.	<b>9 Hours</b>
<b>Module-2</b>	<b>Time-Varying Fields &amp; Maxwell's Equations:</b> Faraday's Law of Electromagnetic Induction, The Displacement Current, Maxwell's Equations in Differential Form, Maxwell's Equations in Integral Form, Time-varying Potential, Retarded Potential, Maxwell's Equations for Sinusoidal Variation of Fields with Time.	<b>9 Hours</b>
<b>Module-3</b>	<b>Electromagnetic Wave Propagation:</b> Wave Propagation in lossy dielectrics, Plane waves in lossless dielectrics, Plane waves in free Space, Plane waves in good conductors, Skin effect, Power and Poynting Vector, Reflection of Plane Wave, Wave Polarization.	<b>8 Hours</b>
<b>Module-4</b>	<b>Transmission Lines:</b> Transmission line parameters, Transmission line equations, Input Impedance, Standing wave ratio, Power, The Smith chart, Applications of transmission line: Quarter wave transformer, Single stub matching.	<b>8 Hours</b>
<b>Module-5</b>	<b>Waveguides:</b> Rectangular Waveguides, Transverse Magnetic Modes, Transverse Electric modes, Wave propagation in the guide, Power transmission and attenuation.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. M. N. O. Sadiku and S. V. Kulkarni, *Principles of Electromagnetics*, 6<sup>th</sup> Edition, Oxford University Press, 2015.

- T2. E. C. Jordan and K. G. Balmain, *Electromagnetic Waves and Radiating Systems*, 2<sup>nd</sup> Edition, Pearson Education, 2009.

#### Reference Books:

- R1. W. H. Hayt and J. Buck, *Engineering Electromagnetic*, 7<sup>th</sup> Edition, McGraw Hill Education, 2006.  
 R2. N. N. Rao, *Fundamentals of Electromagnetics for Engineering*, 1<sup>st</sup> Edition, Pearson Education, 2009.  
 R3. S. Ramo, *Fields and Waves in Communication Electronics*, 3<sup>rd</sup> Edition, John Wiley & Sons, 2007.

#### Online Resources:

1. <https://nptel.ac.in/courses/108104087/>: by Prof. P. Kumar, IIT Kharagpur
2. <https://nptel.ac.in/courses/108/106/108106152/>: by Prof. U. Khankhoje, IIT Madras
3. <https://nptel.ac.in/courses/108/104/108104130/>: by Prof. P. Kumar, IIT Kanpur
4. <https://nptel.ac.in/courses/108/102/108102119/>: by Prof. S. Aditya, IIT Delhi
5. <https://nptel.ac.in/courses/108/101/108101090/>: by Prof. K. Sankaran, IIT Bombay

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain various coordinate system, electrostatic fields and magnetostatic fields.
CO2	Describe time-varying fields and Maxwell's equations on electromagnetics.
CO3	Explain electromagnetic wave propagation through dielectrics, space, and conductors.
CO4	Simulate the behavior of transmission line and explain their applications.
CO5	Articulate the characteristics of waveguide, propagation modes and power transmission.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1							1	2		1
CO2	3	3	1	1	1							1	2		1
CO3	3	3	1	1	1							1	2		1
CO4	3	3	1	3	3								3		
CO5	3	2	3	3	3								3		

Type	Code	Control Systems Engineering	L-T-P	Credits	Marks
PC	18EE1T03		3-0-0	3	100

<b>Objectives</b>	The objective of the course is to create an understanding of how modern-day control systems operate along with a thorough knowledge of mathematical modeling and stability analysis. This course also covers fundamentals of state-space methods.
<b>Pre-Requisites</b>	Mathematical background of differential equation, Laplace transforms, Basic electrical engineering, Dynamic equations of physical systems are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Basic Concepts, Open loop and Closed loop systems, Servo Mechanism/Tracking System; <b>Mathematical Models of Physical Systems:</b> Differential Equations of Physical Systems, Transfer functions, Block Diagram Algebra, Signal flow Graphs; <b>Feedback Characteristics:</b> Reduction of parameter variation, Control over System Dynamics, Control of the effects of disturbance signals, linearizing effect, regenerative feedback.	<b>8 Hours</b>
<b>Module-2</b>	<b>Time Response Analysis:</b> Standard Test Signals, Time response of first & second order systems, type & order of a system, Steady State Errors and Static Error Constants, Effect of adding pole and zero to a system, Design specification of second order system, Performance indices; <b>Concepts of Stability:</b> Necessary conditions for stability, Hurwitz Stability Criterion, Routh Stability Criterion, Relative Stability Analysis; <b>The Root locus technique:</b> Introduction, Root locus concepts, construction of Root locus, Root Contours, Systems with transportation lag.	<b>12 Hours</b>
<b>Module-3</b>	<b>Frequency Response Analysis:</b> Correlation between Time and Frequency Response, Polar plots, Bode plots, All Pass and Minimum- Phase Systems; <b>Stability in Frequency Domain:</b> Mathematical Preliminaries, Nyquist Stability Criterion, Assessment of Relative stability using Nyquist Criterion, Closed loop Frequency Response, Sensitivity Analysis in Frequency Domain.	<b>10 Hours</b>
<b>Module-4</b>	<b>State Variable Analysis:</b> Introduction, Concepts of State, State Variables and State Model, Solution of State Equations, Concepts of Controllability and Observability; <b>Introduction to Controllers:</b> Proportional Derivative Control (PD Control), Proportional Integral Controller (PI Control), Proportional, Integral and Derivative Controller (PID Control), Derivative Output Control; Tuning Rules for PID controllers (Z-N Tuning).	<b>9 Hours</b>
<b>Module-5</b>	<b>Control System Components:</b> Modeling of Stepper motor, AC & DC Servo motor, Synchros, AC Tachometer.	<b>3 Hours</b>
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. I. J. Nagrath and M. Gopal, *Control Systems Engineering*, 5<sup>th</sup> Edition, New Age Intl., 2010.  
 T2. K. Ogata, *Modern Control Engineering*, 5<sup>th</sup> Edition, PHI Learning, 2010.

**Reference Books:**

- R1. S. H. Saeed, *Automatic Control Systems*, 6<sup>th</sup> Edition, S. K. Kataria & Sons, 2008.  
 R2. B. S. Manke, *Linear Control Systems with MATLAB Applications*, Khanna Publications, 1986.  
 R3. U. A. Bakshi and V. U. Bakshi, *Control System Engineering*, 1<sup>st</sup> Edition, Technical Publications, 2010.

**Online Resources:**

1. <https://nptel.ac.in/courses/108102043/>
2. <https://nptel.ac.in/courses/108106098/>
3. <https://www.youtube.com/channel/UCq0imnsn84ShAe9PBOFnoIrg>: Lectures by Brian Douglas
4. <https://ocw.mit.edu/courses/mechanical-engineering/2-04a-systems-and-controls-spring-2013/lecture-notes-labs/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand and apply basic concepts of control system to develop mathematical model of various physical systems in engineering and also study effect of feedback on system characteristics.
CO2	Use standard test signals to determine performance characteristics of first and second-order systems and determine the stability using time domain techniques.
CO3	Identify the methods of frequency domain analysis and apply it to determine different types of stability in frequency domain.
CO4	Differentiate between Transfer Function and State-Space approach of describing a system and understand the design of conventional controllers used in industry.
CO5	Understand different types of control components and its design for reliable and efficient application in industry.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

*Cont'd...*

PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
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**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										2		
CO2	2	3	2	1	1								2	1	
CO3	2	2	1	1	1								2	1	
CO4	3	3	1	1	2	1						1	3	1	1
CO5	2	1		1									1	1	

Type	Code	Signals & Systems	L-T-P	Credits	Marks
PC	18EC1T07		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the presentation, stability, causality, sampling, and reconstruction of various signals & systems in time & spectrum domains.
<b>Pre-Requisites</b>	Fundamental knowledge of basic mathematics is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Signals:</b> Introduction, Classification: continuous/ discrete-time, commonly used continuous-time signals and discrete-time Signals, Analog/ digital signal, Periodic/ aperiodic, Even/ odd, Energy/ power, Deterministic/ random, Operation on Continuous-time and Discrete time signals: Addition, Multiplication, Differentiation/Difference, Integration/Accumulation, Shifting, Scaling, Folding and Convolution (graphical and analytical), Correlation of Discrete-Time signals & its properties.	<b>8 Hours</b>
<b>Module-2</b>	<b>System and LTI/LSI System:</b> Introduction, Classification for both continuous time and discrete time - Linear/ Non-linear, Time varying/ time invariant, Causal/ non-causal, Dynamic/ static, Stable/ unstable and Invertible/ Non-invertible, Continuous time and Discrete time LSI system, System representation through differential equations and difference equations, Response of LSI system and convolution Integral/convolution Sum, Characterization of causality and stability of linear shift invariant(LSI).	<b>8 Hours</b>
<b>Module-3</b>	<b>Analysis by Fourier series and Fourier Transform:</b> Orthogonal and Ortho-normal signal set, Fourier series, convergence of the Fourier series, Trigonometric Fourier series and exponential Fourier series, Continuous time Fourier Transform, convergence of the Fourier transform, Fourier transform of some useful signals, properties of the Fourier transform, the notion of a frequency response and its relation to the impulse response, Parseval's theorem: Energy spectral density, Power spectral density.	<b>9 Hours</b>
<b>Module-4</b>	<b>Analysis by Laplace Transform:</b> Introduction, Region of Convergence for Laplace transform, and properties of ROC, Laplace transform of some useful signals, properties of the Laplace transform, the inverse Laplace transform and Unilateral Laplace Transform and their properties, Initial value and final value theorem, solution of differential equation using Laplace transform.	<b>9 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Sampling and Reconstruction:</b> Discrete-time system analysis using the Z-transform, The Sampling Theorem and its implications - Spectra of sampled signals; Reconstruction: ideal interpolator, Aliasing and its effects, Mapping from S-plane to Z-plane, Z-transform, the region of Convergence, Z- transform of some useful sequences, properties of Z-transform, Inverse Z-transform.	8 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, *Signals and Systems*, 2<sup>nd</sup> Edition, Prentice Hall India, 1992.
- T2. S. Haykin and B. V. Veen, *Signals and Systems*, 2<sup>nd</sup> Edition, John Wiley & Sons, 2002.
- T3. B. P. Lathi, *Principles of Signal Processing and Linear Systems*, 2<sup>nd</sup> Edition, Oxford University Press, 2009.

**Reference Books:**

- R1. A. Ambardar, *Analog and Digital Signal Processing*, 2<sup>nd</sup> Edition, Brooks/Cole Publishing, 1999.
- R2. H. P. Hsu, *Signal and System - Schaum's Outlines*, 2<sup>nd</sup> Edition, McGraw Hill, 2011.
- R3. M. J. Roberts, *Signals and Systems - Analysis using Transform methods and MATLAB*, 2<sup>nd</sup> Edition, McGraw Hill, 2003.
- R4. A. N. Kani, *Signals and System*, 2<sup>nd</sup> Edition, McGraw Hill Education, 2010.

**Online Resources:**

1. <https://nptel.ac.in/courses/117104074/>: by Prof. K.S. Venkatesh, IIT Kanpur
2. <https://nptel.ac.in/courses/108105065/>: by Prof. T.K. Basu, IIT Kharagpur
3. <https://nptel.ac.in/courses/108104100/>: by Prof. A. K. Jagannatham, IIT Kanpur
4. <https://nptel.ac.in/courses/108105059/>: by Prof. S. Mukhopadhyay, IIT Kharagpur
5. <https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/lecture-notes/>
6. <https://engineering.purdue.edu/~mikedz/ee301/ee301.html>
7. <https://stanford.edu/~boyd/ee102/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe different types of signals and systems.
CO2	Analyze various types of LSI systems responses.
CO3	Represent continuous and discrete systems in time & frequency domains using different transforms.
CO4	Investigate the system stability and causality using Laplace Transform and Z-Transform.
CO5	Perform sampling and reconstruction of a given signal.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

*Cont'd...*

PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	3							2	2	
CO2	2		1	2	1	2							1	1	
CO3	3	2	1	1	2	2							2	1	
CO4	3	2	1	1	2	1							2	1	
CO5	3	2	1	1	2	2							2	1	



Type	Code	MEMS & Sensor Design	L-T-P	Credits	Marks
PE	18EI2T47			3-0-0	3

<b>Objectives</b>	The objective of this course is to study the underlying principles of microsystems, advantages of miniaturization, fundamentals of micro-machining and micro-fabrication techniques for designing right type of miniaturized sensors & instruments in different applications.
<b>Pre-Requisites</b>	Fundamental knowledge of sensors and transducers is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on examples & case studies.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Properties of silicon: Crystal structure, Orientation effects, crystal defects, Impurities in Silicon, Properties of Silicon and Gallium Arsenide, Starting materials, Bridgeman techniques for crystal growth.	<b>6 Hours</b>
<b>Module-2</b>	Bulk Micromachining: Wet etching of silicon: Isotropic etching, Anisotropic etching, TMAH, EDP, ultrasonic agitation, quartz-vapour phase etches; Surface Micromachining: Thin film processes non-metallic thin film for micromachining, wet etching, E-beam evaporation, sputtering, deposition by Epitaxy, CVD, PVD, E-plating; Electrodeposition Mechanism: DC electroplating, pulsed electroplating, electroless plating.	<b>10 Hours</b>
<b>Module-3</b>	Bonding Processes: Anodic Bonding, compound processes using bonding; Sacrificial Processes and Other Techniques: Sticking problem, prevention, Sacrificial LIGA process; Advanced MEMS for Sensing and Actuation: Electromechanical effects: Piezoresistance, Piezoelectricity, Shape memory alloy; Thermal effects: Temperature coefficient of resistance, Thermo-electricity, Thermocouples; Micro fluidics, Devices: pumps, valves, mixers; Integrated fluidic systems: BioMEMS and applications.	<b>10 Hours</b>
<b>Module-4</b>	Microsystems Design: Introduction, Design Considerations, Process Design, Mechanical Design, Finite Element Method, Design of a Micropressure Sensor, Design of Microfluidics Network Systems, Computer-Aided Design; Case Study: Design Considerations of Piezoreistive Pressure Sensor.	<b>8 Hours</b>
<b>Module-5</b>	Design of Capacitive Accelerometer: Fundamentals of Quasi-Static Accelerometers, Position Measurement with Capacitance, Circuits for Capacitance Measurement & Demodulation Methods; Design Flow: Specifications, Sensor Design, Modelling, Fabrication and Packaging.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan, K. N. Bhat, and V. K. Aatre, *Micro and Smart Systems*, 1<sup>st</sup> Edition, Wiley India, 2012.
- T2. C. Liu, *Foundations of MEMS*, Illionis ECE Series, Pearson Education, 2006.

- T3. G. T. A. Kovacs, *Micromachined Transducers Source Book*, McGraw-Hill Education, 1998.  
 T4. T. -R. Hsu, *MEMS & Microsystems - Design and Manufacture*, 1<sup>st</sup> Edition, McGraw-Hill Education, 2017.

#### Reference Books:

- R1. S. E. Lyshevski, *Nano- and Micro-Electromechanical Systems : Fundamentals of Nano- and Microengineering (Vol. 8)*, CRC Press, 2005.  
 R2. S. D. Senturia, *Microsystem Design*, Kluwer Academic Publishers, 2001.  
 R3. D. A. Bell, *Electronic Instrumentation and Measurements*, 2<sup>nd</sup> Edition, Oxford University Press, 2007.  
 R4. S. K. Ghandhi, *VLSI Fabrication Principles: Silicon and Gallium Arsenide*, 2<sup>nd</sup> Edition, Wiley, 2008.  
 R5. M. H. Bao, *Micromechanical Transducers: Pressure Sensors, Accelerometers and Gyroscopes*, Elsevier, 2000.

#### Online Resources:

1. <https://nptel.ac.in/courses/108/108/108108113/>: by Prof. H. J. Pandya, IISc Bangalore
2. <https://nptel.ac.in/courses/117/105/117105082/>: by Prof. S. Kal, IIT Kharagpur
3. <https://nptel.ac.in/courses/112/104/112104181/>: by Dr. S. Bhattacharya, IIT Kanpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Recall various materials & techniques used for micromachining.
CO2	Explain the process of micromachining and electrodeposition techniques.
CO3	Elaborate different micromachining bonding processes and the principles of advanced MEMS devices.
CO4	Analyze the steps of Microsystems design for different types of pressure sensors.
CO5	Design accelerometers and explain the steps of design considerations using a case study.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	1								1	1		1
CO2	2	2	3	2								1	2		1
CO3	3	3	3	2								1	3		1
CO4	3	3	2	3								1	2		1
CO5	3	3	2	3								1	2		1

Type	Code	Power Electronics	L-T-P	Credits	Marks
PE	18EE2T54		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to provide an overview of different types of power semiconductor devices and their switching characteristics along with the operation & characteristics of various types of power electronic converters.
<b>Pre-Requisites</b>	Knowledge of physics, basic mathematics, calculus, ordinary differential equations and basic electronics is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Power Semiconductor Devices:</b> Switching and V-I characteristic of devices: Power diode, Transistor Family: BJT, IGBT, and MOSFET, Thyristor family: SCR, TRIAC; Series and parallel grouping of SCR, SCR triggering methods, Isolation of gate and base drive, SCR: Over voltage, Over Current, $dv/dt$ , $di/dt$ , Gate Protection, Snubber circuit, Commutation.	<b>10 Hours</b>
<b>Module-2</b>	<b>AC to DC Converter:</b> Principle of phase controlled converter operation, Single phase full converter with R, R-L, and R-L-E load, 3 phase full converter with R, R-L, and R-L-E load, Single phase semi converter with R, R-L, and R-L-E load, Effect of source inductance, Applications.	<b>10 Hours</b>
<b>Module-3</b>	<b>AC to AC Converter:</b> Single phase bi-directional controllers with R and R-L load, Single phase cycloconverters – Step up and Step down, Applications.	<b>6 Hours</b>
<b>Module-4</b>	<b>DC to DC Converter:</b> First quadrant, Second quadrant, First and second quadrant, Third and fourth quadrant converter. Switching mode regulators: Buck regulators, Boost regulators, Buck-Boost regulators, Isolated Converters, Applications.	<b>8 Hours</b>
<b>Module-5</b>	<b>DC to AC Converter:</b> Voltage Source Inverter (VSI): Single phase Bridge Inverters, 3-Phase Inverters - 180° mode conduction, 120° mode conduction, Voltage control of 3-Phase Inverters by Sinusoidal PWM (PWMVSI), Current Source Inverter (CSI); Applications: UPS, SMPS, Induction Heating, AC/DC drives speed control.	<b>6 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. M. H. Rashid, *Power Electronics: Devices, Circuits, and Applications*, 4<sup>th</sup> Edition, Pearson Education, 2017.
- T2. P. S. Bhimbra, *Power Electronics*, 6<sup>th</sup> Edition, Khanna Publishers, 2014.

#### Reference Books:

- R1. M. D. Singh and K. B. Khanchandani, *Power Electronics*, 2<sup>nd</sup> Edition, McGraw-Hill, 2017.
- R2. P. C. Sen, *Power Electronics*, 1<sup>st</sup> Edition, McGraw Hill India, 2001.

**Online Resources:**

1. <https://nptel.ac.in/courses/108/102/108102145/>: by Prof. G. Bhuvaneshwari, IIT Delhi.
2. <https://nptel.ac.in/courses/108/101/108101126/>: by Prof. V. Agarwal, IISc Bangalore.
3. <https://nptel.ac.in/courses/108/105/108105066/>: by Dr. D. Kastha, Prof. S. Sengupta, Prof. N. K. De, and Prof. D. Prasad, IIT Kharagpur.
4. <https://nptel.ac.in/courses/108101038/>: by Prof. B. G. Fernandes and Prof. K. Chatterjee, IIT Bombay.

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the characteristics of Power semiconductor devices and thyristor family.
CO2	Explain, analyze, and design AC - DC converters for real-world applications.
CO3	Explain, analyze, and design AC - AC converters for real-world applications.
CO4	Explain, analyze, and design DC - DC converters for real-world applications.
CO5	Explain, analyze, and design DC – AC converters for real-world applications.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1							1	3	1	1
CO2	3	1	1	2	1							1	3	2	1
CO3	3	1	1	2	1							1	3	2	1
CO4	3	1	1	2	1							1	3	2	1
CO5	3	1	1	2	1							1	3	2	1

Type	Code	Soft Computing Techniques	L-T-P	Credits	Marks
PE	18EE2T14		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to introduce the concepts of various soft computing techniques like fuzzy logic, neural networks etc., along with optimization techniques/evolutionary computation, and their applications in different fields of engineering.
<b>Pre-Requisites</b>	Knowledge of engineering mathematics and basics of programming is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Basic Tools of Soft Computing:</b> Evolution of Computing - Soft Computing constituents, Difference between soft computing and hard computing; Fuzzy logic, Neural Networks and Evolutionary Computing, Characteristics of Soft computing, Some applications of Soft computing techniques.	<b>6 Hours</b>
<b>Module-2</b>	<b>Fuzzy Logic Systems:</b> Basics of fuzzy logic theory, Crisp and fuzzy sets; Operations on Fuzzy Sets, Membership Functions, Fuzzy relations, Fuzzy rules, Propositions, Implications and inferences, Zadeh's compositional rule of inference, Methods of Defuzzification. <b>Fuzzy Logic Controller:</b> Fuzzy Inference System, Mamdani, Takagi and Sugeno architectures, Examples and applications of fuzzy logic controller.	<b>12 Hours</b>
<b>Module-3</b>	<b>Artificial Neural Networks:</b> Model of an artificial neuron, Neural network architectures, Single layer feedforward network, Multilayer feedforward network, Recurrent networks; Early neural network architectures - Rosenblatt's Perceptron, ADALINE network, MADALINE network, Examples & applications of neural networks.	<b>7 Hours</b>
<b>Module-4</b>	<b>Training of ANN:</b> Generalized delta rule, Hebbian rule; Back propagation algorithm, Effect of tuning parameters of the backpropagation algorithm; Radial Basis Function networks & Least Square training algorithm; Kohonen self-organizing map and learning vector quantization networks; Recurrent neural networks, Simulated annealing neural networks; Adaptive neuro-fuzzy inference systems (ANFIS).	<b>10 Hours</b>
<b>Module-5</b>	<b>Evolutionary Computing:</b> Biological evolution and its application to search techniques, Concept of Genetics, GA architectures, GA operators - Encoding, Crossover, Selection, Mutation, Solving of single-objective optimization problems using GAs; Introduction to other optimization techniques and hybrid evolutionary algorithms.	<b>7 Hours</b>
<b>Total</b>		<b>42 Hours</b>

P.T.O

**Text Books:**

- T1. J. S. R. Jang, C. T. Sun, and E. Mizutani, *Neuro-Fuzzy & Soft Computing - A Computational Approach to Learning and Machine Intelligence*, 1<sup>st</sup> Edition, PHI Learning, 2015.
- T2. S. Rajasekaran and G. A. V. Pai, *Neural Networks, Fuzzy Systems and Evolutionary Algorithms : Synthesis and Applications*, 2<sup>nd</sup> Revised Edition, PHI Learning, 2017.

**Reference Books:**

- R1. F. O. Karry and C. De Silva, *Soft Computing and Intelligent Systems Design - Theory, Tools and Applications*, 1<sup>st</sup> Edition, Pearson Education, 2009.
- R2. S. Haykin, *Neural Networks : A Comprehensive Foundation*, 2<sup>nd</sup> Edition, Pearson Education, 1997.
- R3. T. J. Ross, *Fuzzy Logic with Engineering Applications*, 3<sup>rd</sup> Edition, Wiley, 2011.

**Online Resources:**

1. <https://nptel.ac.in/courses/127/105/127105006/>: by Prof. D. K. Pratihari, IIT Kharagpur
2. <https://nptel.ac.in/courses/106/105/106105173/>: by Prof. D. Samanta, IIT Kharagpur
3. <https://nptel.ac.in/courses/117/105/117105084/>: by Prof. S. Sengupta, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Get an understanding of different soft computing techniques and their applicability.
CO2	Gain insight on fuzzy principles & inference and their implementation in designing fuzzy systems.
CO3	Apply different types of neural networks in electrical & electronics engineering problems.
CO4	Analyze effectiveness of neural networks for solving complex engineering problems.
CO5	Develop knowledge about evolutionary computation with focus on genetic algorithm.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1								1	1	
CO2	3	3	2	2	2							1	2	2	2
CO3	2	1	2	1	2							1	2	2	2
CO4	3	3	2	2	2							1	2	2	2
CO5	2	2	2	2	2							1	1	2	2

Type	Code	Basics of Power Systems	L-T-P	Credits	Marks
OE	18EE3T26		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study different aspects of power systems, the complete path of electrical energy from generation up to the consumers, and various components used in operation & control of modern power systems.
<b>Pre-Requisites</b>	Knowledge of Basic Electrical Engineering is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on real world examples and case studies.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Generation of Electrical Energy:</b> Basics of electrical generation sources - Thermal, Hydro, Nuclear; their layout, basic components, advantages & disadvantages; Renewable Energy: Wind, Solar; their layout, basic components; Grid connected renewable sources, operational issues.	<b>8 Hours</b>
<b>Module-2</b>	<b>Transmission Lines &amp; Substations:</b> Components of transmission lines - conductors & supporting structures, insulators, air gaps, and shielding; DC & AC transmission lines, comparison, underground cables, design parameters, benefits of high-voltage transmission; Substation Equipment - transformers, regulators, circuit breakers, isolators, their relationship to system protection, maintenance & system control; digital substation equipment for modernization & reliability.	<b>9 Hours</b>
<b>Module-3</b>	<b>Distribution System:</b> Primary & secondary, overhead & underground, Consumers - residential, commercial, industrial; voltage classifications, common equipment; modernization & automation, intelligent electronic devices, outage management, customer information systems; <b>Consumption:</b> Wiring to the consumer's load, emergency generators, uninterruptible power supply (UPS), Systems to enhance reliable power service & their operating issues, Smart meters, service reliability indicators, common problems & solutions for large power consumers.	<b>10 Hours</b>
<b>Module-4</b>	<b>System Protection:</b> System vs. Personal protection, protection against equipment failures, faults on power lines, lightning strikes, inadvertent operations, other causes of system disturbances, Protective relays, Protection against faults, lightning strikes, minimization of major system disturbances; Personal protection & safe working procedures in and around high-voltage power systems; Common safety procedures and methods; Equipotential grounding, Ground potential rise, Touch potential, Step potential; precautions around high-voltage power lines, substations, and around the home.	<b>8 Hours</b>

Cont'd...



Module-#	Topics	Hours
Module-5	<b>Interconnected Power Systems:</b> Concept of Interconnection, Hierarchical Grid arrangements, Cascade Tripping, Islanding, Load dispatch center, use of SCADA (Supervisory Control and Data Acquisition) and EMS (Energy Management Systems) for reliable operation of large power systems.	7 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. S. W. Blume, *Electric Power System Basics for the Nonelectrical Professional*, 2<sup>nd</sup> Edition, John Wiley & Sons, 2017.

**Reference Books:**

- R1. V. K. Mehta and R. Mehta, *Principles of Power Systems*, 4<sup>th</sup> Edition, S. Chand, 2005.  
 R2. D. P. Kothari and I. J. Nagrath, *Power System Engineering*, 2<sup>nd</sup> Edition, McGraw-Hill, 2007.  
 R3. A. v'Meier, *Electric Power Systems - A Conceptual Introduction*, John Wiley & Sons, 2006. (eBook available at <https://www.personal.psu.edu/sab51/vls/vonmeier.pdf>).

**Online Resources:**

- <https://nptel.ac.in/courses/108/104/108104052/>: by Dr. S. N. Singh, IIT Kanpur
- <https://nptel.ac.in/courses/108/101/108101040/>: by Dr. A. M. Kulkarni, IIT Bombay

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe various renewable & nonrenewable sources of energy for generation of electrical power.
CO2	Explain fundamental aspects of transmission systems and substation equipment.
CO3	Elaborate the components of a distribution systems and transmission of electrical power up to the consumers' premises.
CO4	Develop an understanding of the basics of electrical protection systems in terms of system protection and personal safety.
CO5	Articulate the concepts, advantages and challenges in operation of large interconnected power systems and role of energy management systems(EMS) for reliable operation of large power systems.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

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PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	1	1		2	1				1	2	1	1
CO2	1	2	1	1	2		2	1				1	3	1	
CO3	1	2	1	1	2		2	1				1	2	2	1
CO4	1	2	1	1	1		2	1				1	2	1	
CO5	1	2	1	1	1		2	1				1	2	1	1

Type	Code	Applied Linear Algebra	L-T-P	Credits	Marks
OE	18BS3T01		3-0-0	3	100

<b>Objectives</b>	The objectives of this course is to gain mathematical maturity by equipping the students to handle computation with matrices, difference equation and similarity transformation for various engineering applications.
<b>Pre-Requisites</b>	Knowledge of complex numbers, matrix algebra, and vector space is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Geometry of Linear Equations, Gauss Elimination, Concept of Matrices with Applications, Vector Spaces and Subspaces, Echelon Form, Solution in Matrix Method, L.I, Basis & Dimension, Four Fundamental Subspaces, Linear Transformations.	<b>9 Hours</b>
<b>Module-2</b>	Orthogonal Vectors & Subspaces, Cosines & Projections onto Lines, Projections & Least Squares, Orthogonal Bases and Gram-Schmidt Process.	<b>8 Hours</b>
<b>Module-3</b>	Introduction & Properties of Determinants, Formulas for Determinant, Applications of Determinants, Introduction to Eigenvalues & Eigenvectors, Diagonalization of Matrix, Difference Equations, Complex Matrices, Similarity Transformations.	<b>8 Hours</b>
<b>Module-4</b>	Maxima, Minima & Saddle Points, Tests for Positive Definiteness, Singular Value Decomposition, Minimum Principles.	<b>8 Hours</b>
<b>Module-5</b>	Introduction to Computations with Matrices, Matrix Norm & Condition Number, Computation of Eigenvalues, Iterative Methods.	<b>9 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

T1. G. Strang, *Linear Algebra and Its Applications*, 4<sup>th</sup> Edition, Cengage Learning, 2007.

#### Reference Books:

R1. G. Strang, *Introduction to Linear Algebra*, 3<sup>rd</sup> Edition, Wellesley-Cambridge, 2003.

#### Online Resources:

1. <https://nptel.ac.in/courses/111/106/111106051/>: by Dr. K. C. Sivakumar, IIT Madras
2. <https://nptel.ac.in/courses/111/102/111102011/>: by Dr. R. K. Sharma and Dr. W. Shukla, IIT Delhi
3. <https://nptel.ac.in/courses/111/108/111108066/>: by Prof. V. Rao, IISc Bangalore
4. <https://nptel.ac.in/courses/111/107/111107106/>: by Prof. P. N. Agrawal and Prof. D. N. Pandey, IIT Roorkee

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain and apply matrix methods for solving a system of linear equations.
CO2	Describe orthogonal & projection in vector space and apply it to least square solution.
CO3	Identify and apply Eigen values and Eigen vectors to diagonalization.
CO4	Explain and apply Singular Value Decomposition and to obtain pseudo inverse of a matrix.
CO5	Develop algorithms and write programs to solve linear algebra problems on computers.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2								2	1	1
CO2	3	2	2	3	2								2	1	1
CO3	3	3	2	2	2								2	1	1
CO4	3	3	3	3	3								2	1	1
CO5	3	3	3	3	3								2	1	1

Type	Code	Fluid Mechanics	L-T-P	Credits	Marks
OE	18BS3T02		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the properties and behavior of fluids including fluid statics, kinematics, dynamics, inviscid flow, flow of viscous fluids, measuring instruments and fluid motive devices.
<b>Pre-Requisites</b>	Basic knowledge of the material properties of solids, liquids and gases and some knowledge of calculus and differential equations are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on engineering applications.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Fluid Properties and Fluid Statics - Density, Specific weight, Specific gravity. Viscosity, vapor pressure, compressibility; Pressure at a point, Pascal's Law and pressure variation with temperature, Density and altitude; Simple and differential manometers, Piezometer, Pressure gauges; Hydrostatic forces on submerged surface, Forces on horizontal and vertical submerged plane surfaces; Buoyancy and flotation, Archimedes' principle, Metacentric height, Stability of immersed and floating bodies.	<b>9 Hours</b>
<b>Module-2</b>	Introduction, Kinematics of fluid flow, Lagrangian and Eulerian descriptions, Conservation of mass -Continuity equation, Differential equation of continuity, Stream line, Path line, Streak lines and Stream tube, Reynolds number and Classification of fluid flow - Steady & unsteady, Uniform & non-uniform, Laminar & turbulent, Rotational & irrotational; One, Two and Three-dimensional flows.	<b>8 Hours</b>
<b>Module-3</b>	Dynamics of Inviscid flows, Surface and body forces, Derivation of Euler's equation and Bernoulli's equation, Applications of Bernoulli's Equation - Venturi meter, Orifice meter, Current meter, Pitot tube; Viscous flow in a pipe/duct - Head loss, Friction factor, Frictional loss in high Reynolds number flow, Effect of wall roughness, Moody chart & illustration by examples; Losses in pipe systems - Pipe entrance/exit, Expansion/contraction, Fittings, Valves, Water level, Velocity & discharge measurements.	<b>9 Hours</b>
<b>Module-4</b>	Brief discussion on acceleration of fluid particles, Continuity equation in 3D flow, Stream function, Velocity potential function; Dynamics of viscous fluids; Momentum balance equation, Control volume approach, Navier-Stokes equations in Cartesian form, Principles of Dimensional Analysis and Similarity, Notch and weir, Impact of Jet, and relevant equations.	<b>8 Hours</b>

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Module-#	Topics	Hours
Module-5	Construction and working principles of - Hydraulic turbines, Impulse turbines, Reaction and Mixed Flow turbines, Hydraulic pumps, Centrifugal pumps & positive displacement types, Characteristic curves of Hydraulic turbines (NHQ).	8 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. S. K. Som, G. Biswas, and S. Chakraborty, *An Introduction to Fluid Mechanics and Fluid Machines*, 3<sup>rd</sup> Edition, McGraw-Hill, 2012.
- T2. E. Rathakrishnan, *Fluid Mechanics - An Introduction*, 3<sup>rd</sup> Edition, Prentice Hall India, 2012.

**Reference Books:**

- R1. R. K. Rajput, *Fluid Mechanics and Hydraulic Machines*, 4<sup>th</sup> Edition, S. Chand Publications, 2008.
- R2. R. K. Bansal, *A Textbook of Fluid Mechanics and Hydraulic Machines*, 9<sup>th</sup> Edition, Laxmi Publications, 2010.

**Online Resources:**

- <https://nptel.ac.in/courses/105/103/105103192/>: by Prof. S. Dutta, IIT Guwahati
- <https://nptel.ac.in/courses/112/105/112105269/>: by Prof. S. Chakraborty, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain and apply the principles of fluid mechanics to solve problems in hydro-statics.
CO2	Analyze different types of fluid flow and evaluate different flow parameters.
CO3	Apply the concepts of fluid dynamics for the flow measuring devices and pipe flows.
CO4	Analyze free surface and 3D flow characteristics and apply them to engineering problems.
CO5	Visualize the construction & working principles of various hydraulic machines.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2								1	1	1	
CO2	3	3	2	2								1		1	
CO3	3	2	2	2	1							1	1	2	1
CO4	3	2	3	2	1							1	1	1	1
CO5	3	3	3	3								1	1	2	1

Type	Code	Fundamentals of DBMS	L-T-P	Credits	Marks
OE	18CS3T04			3-0-0	3

<b>Objectives</b>	The objective of the course is to introduce the fundamental aspects involved in the design, implementation, and operation of relational database systems, learn & use data manipulation language, explore the details of transaction processing, concurrency control, and recovery techniques.
<b>Pre-Requisites</b>	Basic knowledge of data structures, algorithms, and proficiency in any programming language is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on real-world examples.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction to Database Systems:</b> Basic concepts and definitions, three schema architecture, data independence, data models, types of data models, database languages, integrity, database users, Entity-Relationship model, Constraints & Keys, Extended Entity Relationship model, Relational model, Mapping of E-R model to relational schema, System structure of DBMS, Codd's 12 Rules.	<b>10 Hours</b>
<b>Module-2</b>	<b>Query Languages:</b> Relational Algebra, basic operations, join operations, grouping & aggregation, Tuple Relational Calculus, Domain Relational Calculus, Query-By-Example, Structured Query Language (SQL): Create/Alter Tables, Constraints, Selection, Insertion, Modification, Deletion, Functions, Joins, Views.	<b>10 Hours</b>
<b>Module-3</b>	<b>Database Design:</b> Functional dependencies, Armstrong axioms, Attribute closure, Normalization: Dependency & attribute preservation, lossless join; Normal Forms: 1NF, 2NF, 3NF, BCNF, Testing for lossless design, Multi-Valued Dependency (MVD), 4NF and 5NF.	<b>8 Hours</b>
<b>Module-4</b>	<b>Storage Strategies:</b> Storage Architecture, File and Record Organization, Types of Indexes, B-Tree, B+ Tree, Index Files, Hashing; Query processing and optimization: Evaluation of relational algebra expressions, Query optimization.	<b>7 Hours</b>
<b>Module-5</b>	<b>Transaction Processing:</b> Basic concepts, ACID Properties, Serializability, Concurrency Control Schemes – Lock-based & Timestamp-based protocols, Deadlock handling, deadlock prevention, detection and recovery; Database Recovery: types of database failures, Recovery techniques: log-based recovery, checkpoints, shadow paging.	<b>7 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. A. Silberschatz, H. F. Korth, and S. Sudarshan, *Database System Concepts*, 6<sup>th</sup> Edition, McGraw-Hill, 2013.



- T2. R. Elmasri and S. B. Navathe, *Fundamentals of Database Systems*, 7<sup>th</sup> Edition, Pearson Education, 2016.
- T3. I. Bayross, *SQL, PL/SQL - The Programming Language of Oracle*, 1<sup>st</sup> Edition, BPB Publications, 2010.

#### Reference Books:

- R1. R. Ramakrishnan and J. Gekhre, *Database Management Systems*, 3<sup>rd</sup> Edition, McGraw-Hill, 2003.
- R2. R. P. Mahapatra and G. Verma, *Database Management Systems*, 1<sup>st</sup> Edition, Khanna Publishing, 2013.
- R3. C. J. Date, *Introduction to Database Systems*, 8<sup>th</sup> Edition, Pearson Education, 2003.

#### Online Resources:

1. <https://nptel.ac.in/courses/106104135/>: by Prof. A. Bhattacharya, IIT Kanpur
2. <https://nptel.ac.in/courses/106105175/>: by Prof. P. P. Das, IIT Kharagpur
3. <https://cs145-fa18.github.io/>
4. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-830-databasesystems-fall-2010/lecture-notes/>
5. <https://docs.oracle.com/database/121/SQLRF/toc.htm>: Oracle SQL Reference

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the significance of database management system, its functional components, create E-R model and relational schema for databases of real world applications.
CO2	Construct queries using Relational Algebra, Relational Calculus, and perform various database operations using structured query language (SQL).
CO3	Design relational databases based on real-world requirements and normalize the designs using different normalization techniques.
CO4	Get an insight to storage structures, various indexing techniques and access methods using those indexes, and devise optimal query execution strategies for efficient query processing.
CO5	Resolve currency control issues in transaction processing, and recover a database to its current state in case of failures.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	1		2						1	3		3
CO2	3	3	3	2	1	1						2	3		3
CO3	3	3	3	2		1						2	3		3
CO4	2	2	2	2	1	1						1	2		2
CO5	2	3	3	2		2						1	2		3

Type	Code	Transducers & Measurement Systems	L-T-P	Credits	Marks
OE	18EI3T43		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the characteristics of different types of measurement systems and industrial applications of various transducers & sensors for design & construction of precise measuring instruments.
<b>Pre-Requisites</b>	Basic knowledge of physics, mathematics, electrical and electronics is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Definition of measurement, application & types of instruments, functional elements of generalized measurement systems, active/passive transducers, analog/digital mode of operation, null and deflection methods; <b>Static Characteristics:</b> Systematic characteristics, statistical characteristics, calibration; <b>Dynamic Characteristics:</b> Transfer functions of typical sensing elements, step and frequency response of first and second order elements, dynamic errors in measurement systems, dynamic compensation, loading effect, signal & noise.	<b>10 Hours</b>
<b>Module-2</b>	<b>Resistive Transducers:</b> Resistive potentiometers, strain gauges; <b>Inductive Transducers:</b> Variable reluctance displacement sensor, LVDT, RVDT, Hall effect sensors; <b>Capacitive Transducers:</b> Variable separation, area & dielectric displacement transducer, pressure, humidity and level measurement; <b>Translational and Rotational Velocity Measurement:</b> Moving coil moving magnet pickups, Eddy current magnetic & photoelectric pulse counting; <b>Seismic Measurement:</b> Seismic displacement, velocity and acceleration pickups.	<b>10 Hours</b>
<b>Module-3</b>	<b>Temperature Measurement:</b> Thermal expansion methods - Bimetallic, Liquid in glass, Thermocouples (Laws, Characteristics, Installation), RTDs (3-wire & 4-wire type), Thermistors, IC temperature sensors, Radiation detectors, Radiation pyrometer (Narrow Band & Broad Band), Optical pyrometer.	<b>9 Hours</b>
<b>Module-4</b>	<b>Force Measurement:</b> Bourdon tube, bellows, diaphragm, load cell; <b>Torque Measurement:</b> Torsion bar; <b>Pressure Measurement:</b> Units of pressure, dead weight gauges, Manometers, Mc-Leod gauge, Thermal conductivity and Ionization gauges; <b>Flow Measurement:</b> Variable Head (Orifice, Venturi, Pitot static), Variable area (Rotameters), Turbine meters, Electromagnetic flow meters, Ultrasonic flow meters, Doppler velocity meters, Hot wire anemometer and mass flow meter.	<b>7 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Signal Conditioning System:</b> DC Bridge - Wheatstone Bridge, Calibration of the bridge, AC bridges, Linearization by Bridge circuit, Cold junction compensation of Thermocouple, Modulation and Demodulation Techniques, Signal Conditioning System, Signal Transmission.	6 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. A. K. Ghosh, *Introduction to Instrumentation and Control*, 4<sup>th</sup> Edition, PHI Learning, 2012.  
 T2. J. P. Bentley, *Principles of Measurement Systems*, 4<sup>th</sup> Edition, PHI Learning, 2005.

**Reference Books:**

- R1. D. Patranabis, *Sensors and Transducers*, 2<sup>nd</sup> Edition, PHI Learning, 2013.  
 R2. D. V. S. Murthy, *Transducers and Instrumentation*, 2<sup>nd</sup> Edition, PHI Learning, 2008.  
 R3. E. O. Doebelin, *Measurement Systems - Applications and Design*, 6<sup>th</sup> Edition, McGraw Hill, 2007.  
 R4. C. Rangan, G. Sarma, and V. S. V. Mani, *Instrumentation : Devices and Systems*, 2<sup>nd</sup> Edition, McGraw Hill, 2017.  
 R5. B. G. Liptak, *Instrument Engineers' Hand Book (Process Measurement & Analysis)*, 4<sup>th</sup> Edition, CRC Press, 2006.

**Online Resources:**

- <https://nptel.ac.in/courses/108/105/108105088/>: by Prof. S. Mukhopadhyay, IIT Kharagpur
- <https://nptel.ac.in/courses/108/105/108105062/>: by Prof. S. Mukhopadhyay and Prof. S. Sen, IIT Kharagpur
- <https://nptel.ac.in/courses/108/105/108105064/>: by Prof. A. Barua, IIT Kharagpur
- <https://nptel.ac.in/courses/108/108/108108147/>: By Prof. H. J. Pandya, IISc Bangalore

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the principles and characteristics of measuring instruments.
CO2	Explain the use of resistance, inductance and capacitance principles for transducers.
CO3	Identify and utilize various temperature sensors used in industrial applications.
CO4	Articulate the principles and uses of different force, torque, pressure sensors and flow meters.
CO5	Analyze the design of signal conditioning circuits and evaluate their performance.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Cont'd...

PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
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**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1								2	1	1
CO2	2	3	2	2	1								3		
CO3	2	1	2	1	1								1	1	
CO4	2	3	2	3	3								1		
CO5	2	2	2	1	3								1		

Type	Code	Analog Communication Lab	L-T-P	Credits	Marks
PC	18EC1L05			0-0-2	1

<b>Objectives</b>	The objective of this laboratory course is to visualize spectrum of signals, FDM process, modulation schemes, demodulation methods, and simulate through MATLAB & LABVIEW software.
<b>Pre-Requisites</b>	Knowledge on Basic Electronics, MATLAB, and LABVIEW are required.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted using hardware and software tools under the supervision of the teacher; some experiments shall consist of programming assignments.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Analyze and plot the spectrum of following signals with aid of spectrum analyzer: Sine wave, square wave, triangle wave, saw-tooth wave of frequencies 1 KHz, 10KHz, 50KHz, 100KHz and 1 MHz.
2	Analyze the process of frequency division multiplexing and frequency division demultiplexing.
3	Study and design of AM modulator and demodulator (Full AM, DSBSC, SSBSC).
4	Study of FM modulation and Demodulation Techniques.
5	Observer the process of Pulse Amplitude Modulation and Demodulation.
6	Study of quantization and PCM technique.
7	Using MATLAB generate a carrier and a modulating signal, Modulate the carrier using AM, Show the waveform in time domain and analyze its frequency spectrum. Repeat the simulation for modulating signal being square, triangular and other forms of waveform.
8	Using MATLAB generate a carrier and a modulating signal, Modulate the carrier using FM, Show the waveform in time domain and analyze its frequency spectrum. Repeat the simulation for modulating signal being square, triangular and other forms of waveform.
9	Using Lab-View software simulates AM modulation and demodulation system.
10	Using Lab-View software simulate FM modulation and demodulation system.
11	Design a receiver to demodulate and receive the signal from AM radio station.
12	Design a receiver to demodulate and receive the signal from the local FM radio station.

#### Text Books:

- T1. H. Taub, D. L. Schilling, and G. Saha, *Principles of Communication Systems*, 4<sup>th</sup> Edition, McGraw-Hill Education, 2013.
- T2. R. P. Singh and S. D. Sapre, *Communication Systems: Analog and Digital*, 3<sup>rd</sup> Edition, McGraw-Hill Education, 2012.

**Reference Books:**

- R1. M. Salehi and J. G. Proakis, *Communication System Engineering*, 2<sup>nd</sup> Edition, PHI, 2002.
- R2. S. Haykin and M. Moher, *Communication Systems*, 5<sup>th</sup> Edition, John Wiley & Sons, 2009.
- R3. B. P. Lathi, Z. Ding, and H. M. Gupta, *Modern Digital and Analog Communication Systems*, 4<sup>th</sup> Edition, Oxford University Press, 2017.

**Online Resources:**

1. <https://nptel.ac.in/courses/117/105/117105143/>: by Prof. G. Das, IIT Kharagpur
2. [https://nptel.ac.in/content/storage2/nptel\\_data3/html/mhrd/ict/text/117105143/lec60.pdf](https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/117105143/lec60.pdf)
3. <http://www.digimat.in/nptel/courses/video/117105143/L22.html>
4. <http://www.nptelvideos.in/2012/11/communication-engineering.html>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Investigate the different types of spectrum and analyze their bandwidth.
CO2	Explain the process of FDM and its advantages in the field of communication.
CO3	Describe different analog modulation and their application in transmission and reception.
CO4	Differentiate pulse modulation with respect to their type of generation.
CO5	Represent different analog modulation signals using various software.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1			3								2		
CO2	3			3	3								3		
CO3	3			2	1								3		
CO4	3			2	1								3		
CO5	3		3	2	3							2	3		1

Type	Code	Electromagnetic Waves Lab	L-T-P	Credits	Marks
PC	18EC1L06			0-0-2	1

<b>Objectives</b>	The objective of this laboratory course is to visualize curl, divergence, gradient of field, Maxwell's equations, EM wave propagation, etc. The students will get practical exposure on VSWR, reflection coefficient, Smith Chart, radiation patterns, and other characteristics of EM waves.
<b>Pre-Requisites</b>	Basic knowledge of Engineering Physics, Vector Calculus, Electric and Magnetic field and MATLAB is required.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted using hardware and software tools under the supervision of the teacher; some experiments shall consist of programming assignments.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Field vector analysis using MATLAB: (Gradient, Divergence, Curl, Laplacian).
2	Visualising Maxwell's equations using MATLAB.
3	Propagation of electric waves in conductors and dielectrics using MATLAB.
4	Determination of dispersion and group velocity in a parallel plate waveguide using MATLAB.
5	Finding VSWR, reflection coefficient, and input impedance of a transmission line using Smith Chart.
6	Determination of the frequency & wavelength in a rectangular waveguide working in TE <sub>10</sub> mode.
7	Determination of VSWR, reflection coefficient of rectangular wave guide.
8	Rectangular waveguide design using HFSS.
9	Coupling Measurement of H-plane, E-Plane and MagicTee junctions with Transmission Line.
10	Show azimuth and elevation patterns of microstrip patch antenna using HFSS.
11	Radiation Pattern Measurement of a Horn Antenna .
12	Radiation Pattern Measurement of a Yagi-Uda Antenna.

#### Text Books:

- T1. M. N. O. Sadiku and S. V. Kulkarni, *Principles of Electromagnetics*, 6<sup>th</sup> Edition, Oxford University Press, 2015.
- T2. E. C. Jordan and K. G. Balmain, *Electromagnetic Waves and Radiating Systems*, 2<sup>nd</sup> Edition, Pearson Education, 2009.
- T3. C. A. Balanis, *Antenna Theory: Analysis and Design*, 4<sup>th</sup> Edition, John Wiley & Sons, 2016.

#### Reference Books:

- R1. W. H. Hayt and J. Buck, *Engineering Electromagnetic*, 7<sup>th</sup> Edition, McGraw Hill Education, 2006.
- R2. N. N. Rao, *Fundamentals of Electromagnetics for Engineering*, 1<sup>st</sup> Edition, Pearson Education, 2009.



R3. S. Ramo, *Fields and Waves in Communication Electronics*, 3<sup>rd</sup> Edition, John Wiley & Sons, 2007.

#### Online Resources:

1. <https://nptel.ac.in/courses/108104087/>: by Prof. P. Kumar, IIT Kharagpur
2. <https://nptel.ac.in/courses/108/106/108106152/>: by Prof. U. Khankhoje, IIT Madras
3. <https://nptel.ac.in/courses/108/104/108104130/>: by Prof. P. Kumar, IIT Kanpur
4. <https://nptel.ac.in/courses/108/102/108102119/>: by Prof. S. Aditya, IIT Delhi
5. <https://nptel.ac.in/courses/108/101/108101090/>: by Prof. K. Sankaran, IIT Bombay

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Observe various operators such as curl, divergence, gradient and Maxwell's equations.
CO2	Understand the propagation of electric waves in conductors and various dielectrics.
CO3	Determine VSWR, reflection coefficient, and input impedance using Smith Chart.
CO4	Find out the frequency & wavelength in a rectangular waveguide working in TE <sub>10</sub> mode.
CO5	Visualize the radiation patterns of various types of antennas.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	3							1	3		1
CO2	3	3	1	3	3							1	3		1
CO3	3	3	1	3	3							1	3		1
CO4	3	1	1	3	3							1	2		1
CO5	3	1	1	1	3							1	1		1

Type	Code	Control Systems Engineering Lab	L-T-P	Credits	Marks
PC	18EE1L03		0-0-2	1	100

<b>Objectives</b>	The objective of the course is to understand and practice modeling, simulation, and implementation of a physical dynamical system along with an insight to the design of controllers and compensators in modern control system applications.
<b>Pre-Requisites</b>	Knowledge of Dynamic equations of physical systems, Basic Electrical Engineering, Laplace Transform, and Matrix Theory is required.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted using hardware and software tools under the supervision of teachers. Demonstration will be given for each experiment in the pre-lab session.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Study of Position control system using DC Servo motor and determination of its transfer function.
2	Study the characteristics of Synchro Transmitter and Receiver.
3	Observe the time response of a second order process with P, PI and PID controller using process control simulator.
4	Analyze a 2nd order system by plotting its step response using simulation & programming.
5	Verify the effect of P, PI, PD and PID Controller of a 2nd order system using simulation & programming.
6	Study of speed-torque characteristics of two phase ac servomotor and determination of its transfer function.
7	Study the interrelationship between Transfer function and State Space model of a system using simulation & programming.
8	Plot the root locus of a given transfer function using simulation & programming.
9	Study of frequency response of compensator networks and analysis of system stability with compensator using simulation & programming.
10	Study the frequency response of lead, lag compensator network.
11	Study and validate the controllers (ON/OFF and PID) for a temperature control system.
12	Obtain reduced order model of a higher order system using simulation & programming.

### Text Books:

- T1. I. J. Nagrath and M.Gopal, *Control Systems Engineering*, 5<sup>th</sup> Edition, New Age Intl., 2010.
- T2. K. Ogata, *Modern Control Engineering*, 5<sup>th</sup> Edition, PHI Learning, 2010.
- T3. B. S. Manke, *Linear Control Systems with MATLAB Applications*, Khanna Publications, 1986.

**Reference Books:**

- R1. R. Pratap, *Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers*, South Asia Edition, Oxford University Press, 2010.
- R2. S. H. Saeed, *Automatic Control Systems*, 6<sup>th</sup> Edition, S. K. Kataria & Sons, 2008.
- R3. U. A. Bakshi and V. U. Bakshi, *Control System Engineering*, 1<sup>st</sup> Edition, Technical Publications, 2010.

**Online Resources:**

1. <https://nptel.ac.in/courses/108102043/>: by Prof. M. Gopal, IIT Delhi
2. <https://nptel.ac.in/courses/108106098/>: by Prof. P. Ramkrishna, IIT Madras
3. <https://www.youtube.com/channel/UCq0imsn84ShAe9PBOFnoIrg>: Lectures by Brian Douglas
4. <https://ocw.mit.edu/courses/mechanical-engineering/2-04a-systems-and-controls-spring-2013/lecture-notes-labs/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Evaluate the parameters and transfer function of various control components and interpret their application in real world.
CO2	Understand the design of compensators and recognize their use for various applications in interdisciplinary domain.
CO3	Classify between linear and non-linear control actions used in a closed loop system and relate the use of appropriate control scheme for industrial applications.
CO4	Differentiate between Transfer Function and State-space representation of any system dynamics using software tools.
CO5	Analyze and compare the performance of first and second order systems in time domain using hardware and software tools.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1									2		
CO2	2	3	2	1	2								2		
CO3	2	2	1	1									2		
CO4	3	3	1	1	2	1						1	2	2	1
CO5	2	1		1	2								1	2	

Type	Code	Soft Skills & Interpersonal Skills Lab	L-T-P	Credits	Marks
HS	18HS1L02			0-0-4	2

<b>Objectives</b>	The objectives of this laboratory course is to practice language skills to become effective communicators by addressing issues like speaking inhibitions. The lab comprises of individual and team activities based on the four skills of language (LSRW).
<b>Pre-Requisites</b>	Basic knowledge of English grammar and the ability to speak, read, and write using the English language is required.
<b>Teaching Scheme</b>	Regular laboratory classes with various tasks designed to facilitate communication through pair and/or team activities with regular assessments, presentations, discussions, role play, audio-visual supplements, writing activities, business writing practices and vocabulary enhancement.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Communication in a nutshell.
2	Communication in a nutshell.
3	Mock GD 1
4	Mock GD 2
5	Mock GD 3
6	Mock GD 4 (Test)
7	Personality Development
8	Assertiveness
9	Teammanship
10	Leadership
11	Listening
12	Presentation Skills 1
13	Presentation Skills 2
14	Presentation Skills 3
15	Presentation Skills 4
16	Personal Interview 1
17	Personal Interview 2
18	Personal Interview 3
19	Personal Interview 4
20	Mind Mapping
21	Reading Skills 1
22	Reading Skills 2

Cont'd...

Experiment-#	Assignment/Experiment
23	Writing Skills 1
24	Writing Skills 2
25	Writing Skills 3
26	Verbal Ability 1
27	Verbal Ability 2
28	Verbal Ability 3

**Text Books:**

- T1. M. A. Rizvi, *Effective Technical Communication*, 2<sup>nd</sup> Edition, Tata McGraw Hill, 2017.  
 T2. T. Balasubramaniam, *English Phonetics for Indian Students*, 3<sup>rd</sup> Edition, Trinity Press, 2013.  
 T3. M. Raman and S. Sharma, *Technical Communication: Principles and Practice*, 3<sup>rd</sup> Edition, Oxford University Press, 2015.

**Reference Books:**

- R1. S. Samantray, *Business Communication and Communicative English*, 3<sup>rd</sup> Edition, Sultan Chand, 2006.  
 R2. S. John, *The Oxford Guide to Writing and Speaking*, 3<sup>rd</sup> Edition, Oxford University Press, 2013.  
 R3. B. K. Mitra, *Personality Development and Soft Skills*, 2<sup>nd</sup> Edition, Oxford University Press, 2016.  
 R4. B. K. Das et. al., *An Introduction to Professional English and Soft Skills*, Cambridge University Press, 2009.  
 R5. B. K. Mitra, *Effective Technical Communication - A Guide for Scientists and Engineers*, 1<sup>st</sup> Edition, Oxford University Press, 2006.

**Online Resources:**

- [https://owl.purdue.edu/owl/purdue\\_owl.html](https://owl.purdue.edu/owl/purdue_owl.html)
- <https://www.usingenglish.com/>
- <http://www.english-test.net/>
- <https://www.ef.com/wwen/english-resources/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Develop the skills to use English language for effective communication.
CO2	Utilise function of language in context of formality, appropriateness and sensitive issues.
CO3	Formulate and structure sentences using grammatically correct English.
CO4	Compose clear and effective business messages for specific purposes.
CO5	Build up a strong personality and develop skills for efficient public speaking.

**Program Outcomes Relevant to the Course:**

PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

*Cont'd...*

PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						3		1	2	3	2	3	1	3	3
CO2								2	2	3	2	3		3	2
CO3										3		3		2	2
CO4								1	1	3		3		3	3
CO5								1	2	3	1	3		3	3

Type	Code	Digital VLSI Design	L-T-P	Credits	Marks
PC	18EI1T03		3-1-0	4	100

<b>Objectives</b>	The objective of this course is to study the design, fabrication & testing of devices, circuits & systems using integrated micro fabrication technologies providing an in-depth coverage of the state of the art in VLSI technology.
<b>Pre-Requisites</b>	Fundamental knowledge of MOSFET and digital electronics is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Historical Perspective, VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concept of Regularity, Modularity and Locality, VLSI Design Styles; <b>Fabrication of MOSFETs:</b> Introduction, Fabrication Processes Flow – Basic Concepts, The CMOS n-Well Process, Layout Design Rules, Stick Diagrams & Layout of complex CMOS Logic Gates (Euler Method).	<b>11 Hours</b>
<b>Module-2</b>	<b>MOS Transistor:</b> The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitance.	<b>11 Hours</b>
<b>Module-3</b>	<b>MOS Inverter Circuits:</b> Introduction, Voltage Transfer Characteristics, Noise Margin Definitions, NMOS Transistors as Load Devices, CMOS Inverters, Sizing Inverters; <b>Static MOS Gate Circuits:</b> Introduction, CMOS Gate Circuits, Complex CMOS Gates, MUX Circuits, Calculation of Inverter Equivalent for NAND, NOR and other Complex Logic Circuits, Flip-flops and Latches.	<b>12 Hours</b>
<b>Module-4</b>	<b>High Speed CMOS Logic Design:</b> Introduction, Switching Time Analysis, Detailed Load Capacitance Calculation, Improving Delay Calculation with Input Slope, Calculation of Interconnect Parasitics, Calculation of Interconnect Delay (Elmore Delay), Gate Sizing for Optimal Path Delay, Optimizing Paths with Logical Effort, Power Dissipation in CMOS Gates, Power and Delay Tradeoffs.	<b>12 Hours</b>
<b>Module-5</b>	<b>Transfer Gate and Dynamic Logic Design:</b> Introduction, Basic Concepts of Pass Transistor, CMOS Transmission Gate Logic, Dynamic logic, Domino logic, NORA; <b>Basics of Semiconductor Memory:</b> DRAM, SRAM Cell Design & Operation, Memory Architecture; <b>Design for Testability:</b> Introduction, Fault Types and Models, Built-In Self-Test (BIST) Techniques, Current Monitoring IDDQ Test.	<b>10 Hours</b>
<b>Total</b>		<b>56 Hours</b>



**Text Books:**

- T1. S. -M. Kang and Y. Leblebici, *CMOS Digital Integrated Circuits - Analysis and Design*, 3<sup>rd</sup> Edition, TMH, 2002.
- T2. D. A. Hodges, H. G. Jackson, and R. Saleh, *Analysis and Design of Digital Integrated Circuits in Deep Submicron Technology*, 3<sup>rd</sup> International Edition, McGraw Hill Education, 2004.

**Reference Books:**

- R1. J. P. Rabaey, A. P. Chandrakasan, and B. Nikolić, *Digital Integrated Circuits: A Design Perspective*, 2<sup>nd</sup> Edition, Pearson Education, 2016.
- R2. N. H. E. Weste, D. Harris, and A. Banerjee, *CMOS VLSI Design - A Circuits and Systems Perspective*, 4<sup>th</sup> Edition, Pearson Education, 2010.
- R3. R. J. Baker, *CMOS Circuit Design, Layout, and Simulation*, 3<sup>rd</sup> Edition, John Wiley & Sons, 2010.
- R4. D. A. Pucknell and K. Eshraghian, *Basic VLSI Design*, 3<sup>rd</sup> Edition, PHI Learning, 1995.
- R5. J. P. Uyemura, *Introduction to VLSI Circuits and Systems*, John Wiley & Sons, 2006.
- R6. W. Wolf, *Modern VLSI Design - System on Chip Design*, 3<sup>rd</sup> Edition, Pearson Education, 2004.

**Online Resources:**

1. <https://nptel.ac.in/courses/117/106/117106092/>
2. <https://nptel.ac.in/courses/117/106/117106093/>
3. <https://nptel.ac.in/courses/117101058/>
4. <https://nptel.ac.in/courses/108/107/108107129/>
5. <https://nptel.ac.in/courses/106/105/106105161/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Identify suitable method to design circuits and systems using modern tools by following appropriate design flow and fabrication steps.
CO2	Understand the structure and operational analysis of MOSFET under external bias condition before and after scaling.
CO3	Design, implement and investigate Inverter, combinational and sequential logic circuits using CMOS technology.
CO4	Investigate switching characteristics of inverter to estimate its delay time and power consumption.
CO5	Design and analyze transmission gates, various memory cells, acquire the knowledge of different testing techniques and their reliability.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

*Cont'd...*

PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	1	2	1	1	1				2	1	1		1
CO2	3	2		1	1								1		
CO3	2	3	3	1	1							1	2	1	2
CO4	2	1	2	2	1								1		1
CO5	2	2	3	2	1							1	2	1	2

Type	Code	Digital Signal Processing	L-T-P	Credits	Marks
PC	18EC1T08		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study processing of digital signals using Z-transform, discrete Fourier transform, design of IIR & FIR filters, and the concepts of multi-rate signal processing.
<b>Pre-Requisites</b>	Basic knowledge of signals and systems is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Discrete Time Signals: Z-Transform, Region of convergence, Properties, Inverse Z-transform (power series & partial fraction), Analysis of LSI Systems: causality & stability using Z-transform, pole-zero concept and cancellation, transient & steady state response, Unilateral Z-transform & its properties, solution of difference equations.	<b>8 Hours</b>
<b>Module-2</b>	Basics of Discrete Time Fourier Transform (DTFT), frequency domain sampling & reconstruction of discrete time signals; Discrete Fourier Transform (DFT), properties; Linear filtering (overlap add and overlap save), Efficient computation of DFT: Fast Fourier Transform (FFT) Algorithm (Radix-2 DIT and Radix-2 DIF).	<b>9 Hours</b>
<b>Module-3</b>	Structure for Realization of Discrete Time Systems: Structure for IIR Systems - Direct Form I, Direct Form II, Cascade and Parallel Form, Signal Flow Graph and Transposed Structure; Structure for FIR Systems - Direct Form, Cascade Form and Frequency Sampling Structure.	<b>9 Hours</b>
<b>Module-4</b>	Design of Digital Filters: Causality and its implication; Design of FIR filters - symmetric and anti-symmetric, design of Linear Phase FIR filters using Windowing & Frequency Sampling; Design of IIR Filters from analog filters using Impulse invariance & bilinear transformation.	<b>9 Hours</b>
<b>Module-5</b>	Introduction to Multi-rate Signal Processing: Interpolation, Decimation, sampling rate conversion by rational factor; Implementation of sampling rate conversion by poly-phase filter structure.	<b>7 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing : Principles, Algorithms and Applications*, 4<sup>th</sup> Edition, Prentice Hall India, 2007.
- T2. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, *Signals and Systems*, 2<sup>nd</sup> Edition, Prentice Hall India, 1992.
- T3. S. K. Mitra, *Digital Signal Processing : A Computer Based Approach*, 4<sup>th</sup> Edition, McGraw Hill, 2013.

#### Reference Books:

- R1. L. R. Rabiner and B. Gold, *Theory and Application of Digital Signal Processing*, 2<sup>nd</sup> Edition, Prentice Hall India, 1992.
- R2. J. R. Johnson, *Introduction to Digital Signal Processing*, 2<sup>nd</sup> Edition, Prentice Hall India, 1992.
- R3. A. N. Kani, *Digital Signal Processing*, 2<sup>nd</sup> Edition, McGraw Hill Education, 2017.
- R4. P. R. Babu, *Digital Signal Processing*, 4<sup>th</sup> Edition, Scitech Publication, 2011.

#### Online Resources:

1. <https://nptel.ac.in/courses/108/106/108106151/>: by Prof. C. S. Ramalingam, IIT Madras
2. <https://nptel.ac.in/courses/117102060/>: by Prof. S. C. Dutta Roy, IIT Delhi
3. <https://nptel.ac.in/courses/117104070/>: by Prof. T. K. Basu, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the stability and causality of the LSI systems using Z-Transform.
CO2	Analyze discrete signals & systems using DFT technique.
CO3	Realize different structures of FIR and IIR discrete time systems.
CO4	Design IIR and FIR filters using various techniques.
CO5	Describe the basics of Multi-rate Signal Processing.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2		1	2	3							2	2	
CO2	2		2	2	1	2							2	1	
CO3	3	2	1	2	3	2							2	1	
CO4	3	2	3	3	3	1							3	1	
CO5	3	2	1	1	2	2							2	1	

Type	Code	Information Theory & Coding	L-T-P	Credits	Marks
PE	18EC2T45		3-0-0	3	100

<b>Objectives</b>	The objective of the course is to study the concepts of information theory, measuring information using traditional & modern coding techniques including linear block, cyclic, and convolutional codes for error control.
<b>Pre-Requisites</b>	Fundamental knowledge of probability theory, random variables and basics of linear algebra is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Information Theory:</b> Information and entropy, Entropy for discrete ensembles, Properties of entropy of a binary memory less source, Measure of information, Source coding, Shannon's noiseless coding theorem, Shannon-Fano coding, Entropy rate of a stochastic process.	<b>8 Hours</b>
<b>Module-2</b>	<b>Source Coding and Decoding Techniques:</b> Kraft-McMillan Inequality and Compact Codes, Huffman codes and uniquely detectable codes, Arithmetic Coding, Predictive Coding, Lempel Ziv coding.	<b>9 Hours</b>
<b>Module-3</b>	<b>Channel Capacity:</b> Markov Source, Joint and Conditional Information Measures, Properties of Joint and Conditional Information Measures and a Markov Source, Differential entropy, Channel models, Channel capacity, Channel coding, Information capacity theorem, the Shannon Limit Theorem, Channel capacity for MIMO systems.	<b>9 Hours</b>
<b>Module-4</b>	<b>Channel Coding:</b> Introduction to cyclic codes, Polynomials, the Division Algorithm for polynomials, Method for generating cyclic codes, Matrix description of cyclic codes, Burst error correction, Fire codes, Golay codes.	<b>8 Hours</b>
<b>Module-5</b>	<b>Error Control Coding:</b> Introduction to convolutional codes, Tree codes & Trellis codes, Polynomial description of convolutional codes, the Generating Function, Matrix description of convolutional codes, Viterbi decoding of convolutional codes.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. R. Bose, *Information Theory, Coding and Cryptography*, 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2008.
- T2. N. Abramson, *Information and Coding*, McGraw-Hill Education, 1963.

#### Reference Books:

- R1. M. Mansurpur, *Introduction to Information*, McGraw Hill, 1987.
- R2. R. B. Ash, *Information Theory*, Dover Publications, 1990.
- R3. S. Lin and D. J. Costello Jr., *Error Control Coding*, Prentice Hall, 1983.

**Online Resources:**

1. <https://nptel.ac.in/courses/108/103/108103112/>: by Prof. P. K. Bora, IIT Guwahati
2. <https://nptel.ac.in/courses/117/108/117108097/>: by Prof. P. S. Nuggehalli, IISc Bangalore
3. <https://nptel.ac.in/courses/117101053/>: by Prof. S. N. Merchant, IIT Bombay
4. <https://nptel.ac.in/courses/117/104/117104120/>: by Prof. A. Banerjee, IIT Kanpur
5. <https://nptel.ac.in/courses/117/104/117104121/>: by Prof. A. Banerjee, IIT Kanpur
6. <https://nptel.ac.in/courses/117/106/117106031/>: by Dr. A. Thangaraj, IIT Madras

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the concept of information and entropy of a source.
CO2	Explain the Shannon's theorem for coding and source coding techniques.
CO3	Analyze conditional information measure and Markov source.
CO4	Analyze different channels and calculation of channel capacity.
CO5	Apply channel coding techniques for error control.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1								2		
CO2	3	3	1	3	1								3		
CO3	3	2	2	2	2								2		
CO4	3	3	2	3	2								3		
CO5	3	2	3	3	3								3		

Type	Code	Robotics & Robot Applications	L-T-P	Credits	Marks
PE	18EC2T56		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to learn the fundamental concepts of robotics, such as manipulators, kinematics, trajectory planning, control techniques, sensors etc., and basic robot programming for various industrial applications.
<b>Pre-Requisites</b>	Basics of Engineering Mathematics, Digital Electronics, Microprocessors & Microcontrollers, Automation & Control etc., are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on programming & applications.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Robot Fundamentals:</b> History of robotics, Basic concepts, Robot Anatomy, Robot Specification and work volume, Type of robot drives, Basic robot motions, Robot Manipulators, Kinematics, Precision movement.	<b>9 Hours</b>
<b>Module-2</b>	<b>End Effectors:</b> Introduction, Classification, Mechanical, Magnetic, Vacuum and Adhesive gripper, Gripper force analysis & design, Problem on gripper design and force calculation, Robot control - Unit control system concept, Servo & non-servo control of robot joints, Adaptive and optimal control.	<b>8 Hours</b>
<b>Module-3</b>	<b>Sensors:</b> Sensor devices, Types of sensors - contact, position and displacement sensors, force and torque sensors, Proximity and range sensors, Acoustic sensors, Robot vision systems - sensing and digitizing, Image processing and analysis.	<b>8 Hours</b>
<b>Module-4</b>	<b>Robot Programming:</b> Robot language, Classification, Programming methods, Lead through method, Teach pendent method, VAL systems and language, Simple program, Welding robot program, Program on loading/unloading.	<b>9 Hours</b>
<b>Module-5</b>	<b>Industrial Applications:</b> Application of robots, Material handling, Machine loading and unloading, Assembly robot, Inspection, Mobile robot, Microbots, Recent developments in robotics, safety considerations.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. S. R. Deb and S. Deb, *Robotics Technology and Flexible Automation*, 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2009.
- T2. J. J. Crag, *Introduction to Robotics: Mechanics and Control*, 3<sup>rd</sup> Edition, Pearson, 2004.
- T3. S. K. Saha, *Introduction to Robotics*, 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2009.

#### Reference Books:

- R1. R. K. Mittal and I. J. Nagrath, *Robotics and Control*, 1<sup>st</sup> Edition, Tata McGraw-Hill, 2003.
- R2. K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, *Robotics: Control, Sensing, Vision and Intelligence*, 1<sup>st</sup> Edition, McGraw-Hill, 1987.

R3. N. Odrey, M. Weiss, M. Groover, R. N. Nagel, and A. Dutta, *Industrial Robotics: Technology, Programming and Application*, 2<sup>nd</sup> Edition, McGraw-Hill, 2012.

#### Online Resources:

1. <https://nptel.ac.in/courses/112/107/112107289/>: by Prof. N. Sukavanam and Prof. M. F. Orlando, IIT Roorkee
2. <https://nptel.ac.in/courses/112/105/112105249/>: by Prof. D. K. Pratihar, IIT Kharagpur
3. <https://nptel.ac.in/courses/112/101/112101099/>: by Prof. P. Seshu, Prof. P. S. Gandhi, Prof. K. K. Issac, Prof. B. Seth, and Prof. C. Amarnath, IIT Bombay

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe robot fundamentals, drives, Manipulators, movements and kinematics.
CO2	Explain various classes of end effectors and robot control techniques.
CO3	Describe the working of sensors and vision systems and analyze the sensed data.
CO4	Write programs to make the parts of a robot function as per the needs.
CO5	Design & develop robots for various industrial applications in the real world.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

P.T.O



**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	2							1	2		1
CO2	3	3	3	2	3	1						1	3	1	1
CO3	3	3	3	2	3	1						1	3	1	1
CO4	3	3	3	2	3	2						1	3	1	1
CO5	3	2	3	2	2	2	1					1	2	1	1

Type	Code	IoT & Applications	L-T-P	Credits	Marks
PE	18EI2T09		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the design, deployment, protocols, networking, and security aspects of Internet of Things. This course also covers IoT system implementation using Arduino and Raspberry Pi, data analytics, and some case studies in various application domains.
<b>Pre-Requisites</b>	Basic knowledge of computer networks, internet technology, basic electronics, analog electronics, digital electronics and computer programming is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions shall focus on design, programming, and applications of IoT.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Introduction to IoT, Physical Design, Logical Design, Enabling Technologies, Levels & Deployments, M2M, Difference between IoT and M2M, Network Function Virtualization, Need for IoT Systems Management, Simple Network Management Protocol, Limitations of SNMP, Network Operator Requirements, NETCONF, YANG, IoT Systems management with NETCONF YANG, IoT Design Methodology.	<b>9 Hours</b>
<b>Module-2</b>	<b>IoT Strategies:</b> Networking, Communication, Adaptive & Event Driven Processes, Virtual Sensors, Security, Privacy & Trust, Low power communication, Energy harvesting, IoT related standardization; IoT Protocols: MQTT, CoAP, AMQP, JMS, DDS, REST, XMPP.	<b>8 Hours</b>
<b>Module-3</b>	<b>Sensors &amp; Signal Conversion:</b> Sensors for Temperature, Humidity, Pressure, Liquid Level, Vibration; Photo-electric Sensors, Conductive type sensor; Signal conditioning & interfacing; Python Programming: Data Types, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operation, Classes.	<b>8 Hours</b>
<b>Module-4</b>	<b>IoT using Arduino:</b> Interoperability in IoT, Arduino Programming, Integration of Sensors and Actuators, Microcontrollers, Embedded C programming, Analog Interfacing, Serial, SPI, I2C, Ethernet based data Communication; DHCP, Web Client, Telnet, MQTT; IoT using Raspberry Pi: Introduction, Linux on Raspberry Pi, Implementation of IoT with Raspberry Pi, Raspberry Pi Interfaces: Serial, SPI, I2C.	<b>9 Hours</b>
<b>Module-5</b>	<b>Introduction to Data Analytics:</b> Introduction to Apache Hadoop: MapReduce, Hadoop Cluster Setup, YARN, Oozie, Spark, Kafka, Apache Storm; IoT Case Studies: Home Automation, Structural Health Monitoring, Weather Monitoring System, Air Pollution Monitoring, Smart Irrigation, Smart Healthcare, Smart Grid, Renewable Energy Systems, Smart Retail, Smart Machine Diagnosis & Prognosis.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. A. Bahga and V. Madisetti, *Internet of Things: A Hands-On Approach*, 1<sup>st</sup> Edition, Orient Blackswan, 2015.
- T2. O. Vermesan and P. Friess (Ed.), *Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems*, River Publishers, 2013.
- T3. M. Schwartz, *Internet of Things with Arduino Cookbook*, Packt Publishing, 2016.
- T4. A. K. Ghosh, *Introduction to Measurement and Instrumentation*, 3<sup>rd</sup> Edition, PHI, 2009.

**Reference Books:**

- R1. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*, Cisco Press, 2017.
- R2. D. Kellmerit and D. Obodovski, *The Silent Intelligence: The Internet of Things*, 1<sup>st</sup> Edition, Lightning Source Inc., 2013.
- R3. A. McEwen and H. Casimally, *Designing the Internet of Things*, 1<sup>st</sup> Edition, Wiley, 2014.

**Online Resources:**

1. <https://nptel.ac.in/courses/106/105/106105195/>: by Prof. S. Misra, IIT Kharagpur.
2. <https://nptel.ac.in/courses/108/108/108108098/>: by Prof. T. V. Prabhakar, IISc Bangalore
3. <https://nptel.ac.in/courses/106/105/106105166/>: by Prof. S. Misra, IIT Kharagpur
4. <https://nptel.ac.in/courses/108/105/108105064/>: by Prof. A. Barua, IIT Kharagpur
5. <https://nptel.ac.in/courses/106/106/106106182/>: by Prof. S. Iyengar, IIT Madras
6. <https://nptel.ac.in/courses/115/104/115104095/>: by Prof. M. Verma, IIT Kanpur
7. <https://nptel.ac.in/courses/106/104/106104189/>: by Dr. R. Misra, IIT Patna

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the basics of IoT technologies, design methodologies and network management protocols.
CO2	Evaluate the IoT deployment strategies and communication protocols.
CO3	Describe the concepts of sensors, interfacing methodologies and their application to IoT.
CO4	Develop programs for IoT Applications using Arduino and Raspberry Pi.
CO5	Develop IoT solutions for specific applications and perform data analytics.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
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**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	1									1		
CO2	2	2	2	1	2								2		
CO3	3	2	3	1	3								3		
CO4	3	3	3	1	3							1	3		1
CO5	3	3	2	2								1	2		1

Type	Code	Power Station Engineering	L-T-P	Credits	Marks
OE	18EE3T39		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study various aspects and working of principles of power plants based on different fuels, their cost-benefit analysis, safety, and environmental issues.
<b>Pre-Requisites</b>	Basics of mechanical engineering, thermodynamics, and basic electrical engineering are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction: Sources of Energy and Generation, Indian Energy Scenario; Prediction of Load: Connected Load, Maximum Load, Demand Factor, Average Load, Load Factor, Load Duration Curves, Diversity Factor, Choice of Type of Generation, Capacity Factor, Reserve Factor, Plant Use Factor, Base Load, Intermediate Load, Peak Load Plants; Economics of Power Generation: Costs - Construction cost, Fixed cost, Costs for energy, Depreciation of plant, Fuel cost; Economic scheduling principle, Annual operating costs, Effect of Load Factor on cost, Tariff.	<b>9 Hours</b>
<b>Module-2</b>	Hydro Electric Power Station: Selection of site, Hydrological cycle, precipitation, run-off, hydrograph, flow duration & mass curves, Estimation of water held by a dam, Storage & Pondage, Earthen & Concrete Dams; Turbines: Kaplan & Francis Turbine, Pelton wheel, Speed & Pressure Regulation, Work done & Efficiency; Arrangement & location of Hydroelectric Station: Catchment area, Reservoir, Dam, Head Gate, Spillways, Pen stock, Surge Tanks, Scroll case, Draft tubes & Tail Race, Power House, Pump storage plant.	<b>10 Hours</b>
<b>Module-3</b>	Nuclear Power Station: Fission & Fusion, Principle of Nuclear Energy, Reactor Construction, Controlled Chain Reaction, Power Reactors: Pressurized Water Reactor, Boiling Water Reactor, Pressurized Heavy Water Reactor, CANDU Reactor, Gas Cooled & Liquid Metal Cooled Reactors; Operational Control of Reactors, Breeder, Location & layout of nuclear power plant.	<b>8 Hours</b>
<b>Module-4</b>	Thermal Power Station: Selection of site; Main parts & working of a Steam Station, Overall Block Diagram indicating the air circuit, coal & ash circuit, water & steam circuit, Types of steam turbines, Ash & coal handling system, High Pressure and High capacity water tube boilers, Super heaters, De-Super heater, Re-heater, Air Pre-heater; Ultra mega power project, Fluidized bed boiler technology.	<b>8 Hours</b>

*Cont'd...*

Module-#	Topics	Hours
Module-5	Fuel handling plant, water treatment plant, Draft System: Natural, Induced, Forced & Balanced Draft, ID fan, PA fan, FD fan, Chimney, Condenser, Feed water heaters, Evaporators, Make-up water, Bleeding of steam, Cooling water system; Electrostatic precipitator, Water treatment plant, Turbine, Fluidized bed combustor, Economizer, Generators, Dust collector system, Condenser, Cooling tower, Feed water pump.	7 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. P. K. Nag, *Power Plant Engineering*, 4<sup>th</sup> Edition, Tata McGraw Hill, 2014.  
 T2. M. V. Deshpande, *Elements of Electrical Power Station Design*, 3<sup>rd</sup> Edition, PHI, 2010.  
 T3. B. G. A. Skrotzki and W. A. Vopat, *Power Station Engineering and Economy*, 2<sup>nd</sup> Edition, Tata McGraw Hill, 1988.

**Reference Books:**

- R1. S. C. Arora, S. Domkundwar, and A. V. Domkundwar, *A Course in Power Plant Engineering*, 6<sup>th</sup> Edition, Dhanpat Rai & Sons, 2013.  
 R2. R. K. Rajput, *A Text Book of Power Plant Engineering*, 3<sup>rd</sup> Edition, Laxmi Publishing, 2012.

**Online Resources:**

- <https://nptel.ac.in/courses/108/105/108105058/>: by Prof. S. Banerjee, IIT Kharagpur
- <https://nptel.ac.in/courses/112/103/112103275/>: by Prof. D. N. Basu, IIT Guwahati
- <https://nptel.ac.in/courses/112/106/112106133/>: by Prof. J. M. Mallikarjuna, Prof. U. S. P. Shet, and Prof. T. Sundararajan, IIT Madras

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Estimate loads, generation patterns, their behavior and cost benefit analysis of different types of power stations.
CO2	Describe the operation of hydro power plant, different heads, and turbine modeling.
CO3	Evaluate the performance of nuclear power station and realize associated problems.
CO4	Explain the operation of the thermal power plant and related mechanical functions.
CO5	Identify and describe different components of a thermal power plant.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Cont'd...

PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
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**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2					2						2	1	1
CO2	1	2	2	3			2						2	1	
CO3	1	2	1	1			2						3	1	
CO4	1	1	2	3			2						2	1	
CO5	1	1	2	1			2						2	2	

Type	Code	Numerical Optimization	L-T-P	Credits	Marks
OE	18BS3T06			3-0-0	3

<b>Objectives</b>	The objectives of this course is to gain mathematical maturity by equipping the students to handle the linear and non linear problems of optimization in different fields of engineering.
<b>Pre-Requisites</b>	Knowledge of coordinate geometry, calculus and matrix algebra is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Linear Programming: Graphical Method, Simplex Method, Methods of Artificial Variables, Alternate Optima, Redundancy & Degeneracy.	<b>8 Hours</b>
<b>Module-2</b>	Mathematics of Simplex Method (without proof), the Revised Simplex Method, Dual Problem, Construction of Dual, Duality Theorem (without proof), Dual Simplex Method, Post Optimal analysis.	<b>9 Hours</b>
<b>Module-3</b>	Integer Linear Programming: Gomory's cutting Plane Method for All Integer & Mixed Integer Programming, Branch & Bound Method, Convex Function, Convex Programming Problem, Quadratic Programming and Wolfe's Method.	<b>8 Hours</b>
<b>Module-4</b>	Optimality Conditions, Lagrangian & Lagrange Multipliers, KKT Necessary/Sufficient Optimality Conditions, Duality in Non-linear Programming, Unconstrained Optimization: Line Search Methods for Unimodal Functions, Steepest Descent Method, Newton's Method, Modified Newton's Method, Conjugate Gradient Method.	<b>9 Hours</b>
<b>Module-5</b>	Introduction to computations with matrices, Matrix norm & condition number, computation of Eigen values, Iterative methods.	<b>9 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. S. Chandra, Jayadeva, and A. Mehera, *Numerical Optimization with Applications*, 1<sup>st</sup> Edition, Narosa Publisher, 2013.

#### Reference Books:

- R1. D. G. Luenberger and Y. Ye, *Linear & Nonlinear Programming*, 1<sup>st</sup> Edition, Springer, 2016.  
 R2. S. S. Rao, *Engineering Optimization - Theory and Practice*, 4<sup>th</sup> Edition, John Wiley & Sons, 2013.  
 R3. K. Dev, *Optimization for Engineering Design - Algorithms and Examples*, 2<sup>nd</sup> Edition, PHI, 2012.

#### Online Resources:

1. <https://nptel.ac.in/courses/106108056/>: Dr. S. K. Shevade, IISc Bangalore



**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Apply simplex method to solve linear programming problems.
CO2	Explain the concepts behind simplex method and apply it to sensitivity analysis.
CO3	Apply integer programming and convex programming methods in optimization problems.
CO4	Explain the concepts and conditions of non-linear programming problems and its application.
CO5	Solve constrained optimization problems by applying advanced optimization techniques.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	1								2	1	1
CO2	3	3	2	1	2								2	1	1
CO3	3	2	3	3	1								2	1	1
CO4	3	3	3	2	3								2	1	1
CO5	3	3	3	2	3								2	1	1

Type	Code	Organizational Behaviour	L-T-P	Credits	Marks
OE	18BS3T07		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to understand the human interactions in an organization and develop the skills for leadership, conflict resolution and take rational decisions to attain business goals.
<b>Pre-Requisites</b>	General knowledge of any organization and its operations is sufficient.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with real-life examples.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction: Concept and Importance of Organizational Behaviour; Learning-Nature of Learning, Components of learning, Learning Cycle, Theories of Learning; Personality - Concept, Determinants of Personality, Personality Traits, Personality and OB.	<b>9 Hours</b>
<b>Module-2</b>	Perception and Motivation: Perception - The Concept of Perception, The perceptual process, Importance of Perception in OB; Motivation: Nature and Importance, Herzberg's Two Factor Theory, Maslow's Need Hierarchy Theory, Alderfer's ERG Theory.	<b>8 Hours</b>
<b>Module-3</b>	Organizational Behaviour Process: Communication-Concept, Importance, Types, Gateways and Barriers to Communication; Communication as a tool for improving Interpersonal Effectiveness. Groups in Organizations: Nature and Types of Groups, Group Cohesiveness and Group Decision-making with Managerial Implications, Effective Team Building. Leadership: Leadership and Management, Theories of Leadership, Conflict-Nature of Conflict and Conflict Resolution.	<b>9 Hours</b>
<b>Module-4</b>	Organizational Culture and Human Resource Management: Organizational Culture: Concept of Organizational Culture and Organizational Effectiveness; Human Resource Management: Selection, Orientation, Training and Development, Performance Appraisal.	<b>8 Hours</b>
<b>Module-5</b>	Organizational Change: Importance of Change, Planned Change and OB techniques; International Organizational Behavior: Cultural Differences and Similarities, Individual and Interpersonal Behavior in Global Perspective, Trends in International Business.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. K. Davis, *Organisational Behaviour*, 9<sup>th</sup> Edition, McGraw-Hill, 1992.
- T2. K. Aswathappa, *Organisational Behaviour*, 12<sup>th</sup> Rev. Edition, Himalaya Publishing House, 2016.

#### Reference Books:

- R1. S. P. Robbins, *Organisational Behaviour*, 8<sup>th</sup> Edition, Prentice Hall of India, 2018.

- R2. K. B. L. Srivastava and A. K. Samantaray, *Organizational Behaviour*, 1<sup>st</sup> Edition, India Tech, 2009.  
 R3. K. Singh, *Organizational Behaviour*, 3<sup>rd</sup> Edition, Pearson, 2015.

#### Online Resources:

1. <https://nptel.ac.in/courses/110/105/110105033/>: by Dr. S. Mukhopadhyay, IIT Kharagpur
2. <https://nptel.ac.in/courses/110/105/110105120/>: by Prof. K. B. L. Srivastava, IIT Kharagpur
3. <https://www.studocu.com/en/search/organizational-behaviour>: by different universities

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the developments in the field of OB and the micro & macro approaches inside organizations.
CO2	Analyze and compare different models used to explain individual behaviour related to motivation, learning, perception and personality.
CO3	Identify the processes used in developing communication, interpersonal relations and resolving conflicts.
CO4	Explain the role of group dynamics, demonstrate skills required for working in groups, team building and various leadership styles.
CO5	Explain the need of organizational culture and identify the process and barriers for implementing organizational change.

#### Program Outcomes Relevant to the Course:

PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1	1	1	1			1		1	1
CO2						1	1	2	1	1		1		2	1
CO3						1		2	3	3		1		2	2
CO4						1	2	1	3	1		1		3	2
CO5						2	1	1	1	1		1		2	1

Type	Code	Operating Systems	L-T-P	Credits	Marks
OE	18CS3T09		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to understand the fundamental concepts, techniques & algorithms, and internal working principles of a computer operating system to become a system designer or an efficient application developer.
<b>Pre-Requisites</b>	Knowledge of computer programming and data structures is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Overview, Evolution of operating system, Types of systems - Batch Processing, Multiprogramming, Time Sharing systems; Personal Computers, Parallel, Distributed, and Real-time Systems; Operating System Services, System components, System calls.	<b>6 Hours</b>
<b>Module-2</b>	<b>Process Management:</b> Process concepts, states, PCB, Process scheduling queues, queuing diagram, Types of schedulers, Operations on process; Inter-process communication - shared memory, message passing, Concept of buffering, Thread overview, Benefits of multi-threaded program, User and kernel threads, Multi-threading models, Issues with multi-threading - thread cancellation, thread pools, thread specific data; <b>CPU Scheduling:</b> Dispatcher, Scheduling - Criteria, Algorithms - FCFS, SJF, SRTF, RR, Priority, Multi-level Queue (MLQ), MLQ with Feedback.	<b>10 Hours</b>
<b>Module-3</b>	<b>Process Synchronization:</b> Background, Bounded-buffer – Shared-memory solution to Producer-consumer problem, Race condition, Critical section problem - Peterson's solution, Synchronization hardware: TestAndSet(), swap() instructions, Semaphores - Counting and binary semaphore, spinlocks, Classical problems of synchronization - Bounded-buffer problem, Readers-writers problem, Dining-philosophers problem, Monitors; <b>Deadlock:</b> System model, characterization, Resource-allocation graph, Methods for handling deadlocks, Deadlock prevention & avoidance, Banker's algorithm, Deadlock detection & recovery.	<b>10 Hours</b>
<b>Module-4</b>	<b>Memory Management:</b> Background, Logical & physical address space, Dynamic loading & dynamic linking, Swapping, Contiguous memory allocation, Dynamic storage allocation problem, Overlays, Paging, Segmentation; <b>Virtual Memory:</b> Background, Demand paging, Page fault, Basic page replacement policy, Page replacement algorithms - FIFO, OPT, LRU, LRU-Approximation, LFU, MFU, Thrashing, Working-set model.	<b>9 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Secondary Storage Structure:</b> Overview of mass storage structure, Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK, Swap-space management, RAID structure; <b>File System:</b> Concept, Access methods, Directory structure, Directory implementation, Allocation methods, Free space management, Access control list; <b>I/O System:</b> Polling, Interrupts, DMA; <b>Case Studies:</b> The LINUX System.	7 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. A. Silberschatz, P. B. Galvin, and G. Gagne, *Operating System Concepts*, 8<sup>th</sup> Edition, Wiley, 2009.  
 T2. M. Milenković, *Operating Systems: Concepts and Design*, 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2001.

**Reference Books:**

- R1. A. S. Tanenbaum, *Modern Operating Systems*, 3<sup>rd</sup> Edition, PHI, 2009.  
 R2. P. B. Prasad, *Operating Systems and System Programming*, 2<sup>nd</sup> Edition, Scitech Publications, 2015.

**Online Resources:**

- <https://nptel.ac.in/courses/106/102/106102132/>: by Prof. S. Bansal, IIT Delhi
- <https://nptel.ac.in/courses/106/108/106108101/>: by Prof. P. C. P. Bhatt, IISc Bangalore
- <https://nptel.ac.in/courses/106/106/106106144/>: by Prof. C. Rebeiro, IIT Madras
- <https://nptel.ac.in/courses/106/105/106105214/>: by Prof. S. Chattopadhyay, IIT Kharagpur
- <https://www.cse.iitb.ac.in/~mythili/os/>: Notes & slides by Prof. M. Vutukuru, IIT Bombay
- <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-828-operating-system-engineering-fall-2012/lecture-notes-and-readings/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explore principles behind various types of operating systems, system components, system calls, protection mechanisms and services.
CO2	Explain different schedulers, scheduling policies, and design new scheduling algorithms for real life problems.
CO3	Describe the significance of process synchronization through classical synchronization problems and deadlock handling mechanisms.
CO4	Describe the working principle of main memory, cache memory and virtual memory organization and solve memory related problems.
CO5	Articulate secondary storage management, and analyze the performance of various disk scheduling algorithms.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

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PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2									2	2	2	
CO2	3	3	3	2								2	3	3	1
CO3	3	3	3	2	1	1						2	3	3	1
CO4	3	3	3	2	1	1						1	3	3	1
CO5	2	2	3	2	1	1						1	3	3	1

Type	Code	Programming in Python	L-T-P	Credits	Marks
OE	18CS3T10		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study object oriented programming using the Python programming language. Knowledge of Python will be useful for studying Machine Learning, Artificial Intelligence, and Data Science.
<b>Pre-Requisites</b>	Basic analytical & logical skill is required for this course. Prior experience with any other programming language will be beneficial.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with programming & problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours		
<b>Module-1</b>	<b>Introduction to Python:</b> Features of Python, Executing a python program, Interactive and non-Interactive modes, Basic syntax, Data types, Variables, Literals, Input/output statements, Keywords, Identifiers, Operators, Precedence & associativity, Expressions, Control statements.	<b>8 Hours</b>		
<b>Module-2</b>	<b>Arrays, Strings, and Lists:</b> Operations, Slicing, Built-in list function, List comprehension, Tuples - Introduction, Accessing elements, Operations using built-in tuple functions, Dictionaries - Introduction, Accessing values in dictionaries, Built-in dictionary functions, Sets, Function, Recursion; <b>Modules:</b> Creating modules, Import statement, Packages.	<b>10 Hours</b>		
<b>Module-3</b>	<b>Object Oriented Programming:</b> Features, Classes & objects, Creating class & object, Using a class, Methods; <b>Inheritance:</b> Types of inheritance, Overriding methods, Encapsulation & information hiding, Polymorphism, Operator overloading, Method overloading & overriding, Abstract method & class; <b>Exception Handling:</b> Errors, Types of exception, try, except, and finally, assertion.	<b>9 Hours</b>		
<b>Module-4</b>	<b>File Handling:</b> Types of files, Opening & closing, Reading & writing, Binary files; Command line arguments; <b>Database Connectivity:</b> Introduction, Connections, Executing queries, Transactions, SQLDB database connection parameters, Insert, Update, Delete.	<b>9 Hours</b>		
<b>Module-5</b>	<b>Regular Expression:</b> Match function, Search function, Matching vs. Searching, Quantifiers, Pattern; <b>CGI:</b> Introduction, Architecture, CGI environment variables, GET & POST methods, Cookies, File upload; <b>Graphical User Interface:</b> GUI toolkits, Creating GUI widgets with Tkinter, Creating layouts, Radio buttons, Checkboxes, Dialog boxes.	<b>6 Hours</b>		
<b>Total</b>				<b>42 Hours</b>

#### Text Books:

- T1. R. N. Rao, *Core Python Programming*, 2<sup>nd</sup> Edition, DreamTech Press, 2019.
- T2. P. Barry, *Head First Python*, 2<sup>nd</sup> Edition, O'Reilly Media, 2010.
- T3. A. Downey, *Think Python*, 2<sup>nd</sup> Edition, Green Tea Press, 2015.

**Reference Books:**

- R1. J. Zelle, *Python Programming: An Introduction to Computer Science*, 3<sup>rd</sup> Edition, Franklin, Beedle & Associates, 2016.
- R2. L. Ramalho, *Fluent Python*, 1<sup>st</sup> Edition, O'Reilly Media, 2015.
- R3. M. Lutz, *Programming Python*, 4<sup>th</sup> Edition, O'Reilly Media, 2011.

**Online Resources:**

1. <https://nptel.ac.in/courses/106/106/106106145/>: by Prof. M. Mukund, IIT Madras
2. <https://help.uis.cam.ac.uk/service/help-support/training/downloads/course-files/programming-student-files/python-courses/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explore Python syntax and use Python flow control to solve simple problems.
CO2	Implement knowledge of functions and different data structures like list, tuple, and dictionary.
CO3	Develop applications using object oriented programming concepts in Python.
CO4	Apply the concept of file handling and database connectivity in real life problems.
CO5	Implement regular expressions and develop GUI based Python applications.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1		1						1	1		2
CO2	3	2	1	1		1						1	3		3
CO3	3	2	1	1		1						1	3		3
CO4	3	2	1	1		2						2	2		1
CO5	2	2	1	1		1						2	2		2



Type	Code	Industrial Automation & Control	L-T-P	Credits	Marks
OE	18EI3T11			3-0-0	3

<b>Objectives</b>	The objective of this course is to study the principles, operation, tuning, configuration and applications of process control elements including PLC and DCS for industrial uses and real time programming.
<b>Pre-Requisites</b>	Knowledge of basic electrical engineering and control system is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Process Control:</b> Introduction to Process Control, Process Definition, Feedback Control; Controller Types: Discontinuous, Continuous, and Composite; PID Controller Tuning: Zeigler-Nichols Tuning Method, Process Reaction Curve; Digital PID Controllers: Position and Velocity algorithm.	<b>10 Hours</b>
<b>Module-2</b>	<b>Final Control Elements:</b> Pneumatic systems - Flapper nozzle system and its characteristics, I/P converter and pneumatic actuators; Electrical actuators: Solenoids, motors, principle of stepper motors, elements of power electronic devices and driver circuits, hydraulic actuators; Control valve: Types of control valve, control valve sizing, cavitation and flashing.	<b>8 Hours</b>
<b>Module-3</b>	<b>Special Control Structures:</b> Cascade Control, Feed forward Control, Feed forward-Feedback Control Configuration, Ratio Control, Selective Control and Adaptive Control Configuration.	<b>8 Hours</b>
<b>Module-4</b>	<b>Industrial Automation:</b> Programmable Logic Controllers: Introduction, Principles of operation, Architecture, Programming (Programming Languages, Ladder Diagram, Boolean Mnemonics); Distributed Control System: Distributed vs. Centralized, Advantages, Functional Requirements, System Architecture, Distributed Control Systems (DCS), Communication options in DCS.	<b>10 Hours</b>
<b>Module-5</b>	<b>Real-time Programming:</b> Multi-tasking, Task Management, Inter-task Communication, Real-time Operating System.	<b>6 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. S. Bhanot, *Process Control: Principles and Applications*, 1<sup>st</sup> Edition, Oxford University Press, 2008.
- T2. K. Kant, *Computer-Based Industrial Control*, 2<sup>nd</sup> Edition, PHI, 2009.
- T3. C. D. Johnson, *Process Control Instrumentation Technology*, 8<sup>th</sup> Edition, Pearson, 2014.
- T4. D. R. Coughnowr, *Process System Analysis and Control*, 3<sup>rd</sup> Edition, McGraw Hill, 2009.

#### Reference Books:

- R1. J. Stenerson, *Industrial Automation and Process Control*, 3<sup>rd</sup> Edition, Prentice Hall, 2003.
- R2. C. A. Smith and A. B. Corripio, *Principles and Practice of Automatic Process Control*, 3<sup>rd</sup> Edition, John Wiley & Sons, 2006.

R3. M. Gopal, *Digital Control and State Variable Methods*, 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2003.

**Online Resources:**

1. <https://nptel.ac.in/courses/108/105/108105088/>: by Prof. S. Mukhopadhyay, IIT Kharagpur
2. <https://nptel.ac.in/courses/108/105/108105062/>: by Prof. S. Sen and Prof. S. Mukhopadhyay, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the process, characteristics, types of controllers, and PID controller tuning.
CO2	Identify the type of final control elements and explain its working principles.
CO3	Examine & troubleshoot the various controller structures and their configurations.
CO4	Apply the knowledge of PLC and DCS for automating industrial processes in real world.
CO5	Utilize the concepts of real-time programming to design industrial automation systems.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	1						1	2		
CO2	2	1	1	1	1		1						1		
CO3	2	1	1		2								1		
CO4	2	2	1	2	3	1	1	1				1	3	1	1
CO5	2	1	1										1		

Type	Code	Biology for Engineers	L-T-P	Credits	Marks
BS	18BS1T11		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to integrate the knowledge of traditional engineering and modern biology to solve problems encountered in living systems, allow engineers to analyze a problem from both an engineering and biological perspective, anticipate specific issues in working with living systems, and evaluate possible solutions.
<b>Pre-Requisites</b>	Basic knowledge of biology, chemistry, and physics is adequate.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction to Biology:</b> Chemical foundations and basic chemistry of cell – Carbon compounds and cell as a unit of life; Physical and chemical principles involved in maintenance of life processes; Cell Structure & Functions – Ultra-structure and functions of cellular components (Prokaryotic and Eukaryotic cells), cell wall, plasma membrane, endoplasmic reticulum; Biomolecules – Carbohydrates, Lipids, Amino Acids, Proteins, Nucleic acids; Tissue systems – Overview of animal and plant tissue systems.	<b>8 Hours</b>
<b>Module-2</b>	<b>Metabolisms &amp; Cell Division:</b> Exothermic and endothermic versus endergonic and exergonic reactions; Concept of $K_{eq}$ and its relation to standard free energy, Spontaneity, ATP as an energy currency, breakdown of glucose (Glycolysis and Krebs cycle) and synthesis of glucose (Photosynthesis), Energy yielding and energy consuming reactions, Concept of Energy charge Morphology of chromosomes; Cell theory – Cell cycle and phases; Mitosis and meiosis.	<b>8 Hours</b>
<b>Module-3</b>	<b>Genetics &amp; Organic Evolutions:</b> Laws of heredity – Biological indicators, bio-sensors; Mutations – Cause, types and effects on species; Molecular Genetics: Structures of DNA and RNA; Origin of life – Haldane and Oparins concepts; Modern concept of natural selection and speciation – Lamarkism, Darwinism/Neo-Darwinism.	<b>8 Hours</b>
<b>Module-4</b>	<b>Microbiology &amp; Immunology:</b> Concept of single celled organisms, Concept of species and strains, Identification and classification of microorganisms, Microscopy, Ecological aspects of single celled organisms, Sterilization and media compositions, Growth kinetics. Microbial diseases, epidemiology and public health; Human immune mechanism – Types of immunities; Antigen/Antibody reactions – Applications in human health; Immunological disorders: Auto-immune diseases.	<b>10 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Biochemistry &amp; Biotechnology:</b> Amino acids & Proteins – Classification based on function and structure; Protein synthesis – Components and regulatory mechanisms; Enzymes – An overview; Biotechnology: Basic concepts on Totipotency and Cell manipulation; Plant & Animal tissue culture – Methods and uses in agriculture, medicine and health.	7 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. Wiley Editorial, *Biology for Engineers*, John Wiley & Sons, 2018.
- T2. McGraw-Hill Editorial, *Biology for Engineers*, McGraw-Hill Education, 2013.

**Reference Books:**

- R1. A. T. Johnson, *Biology for Engineers*, 1<sup>st</sup> Edition, CRC Press, 2010.
- R2. S. Singh, T. Allen, *Biology for Engineers*, 1<sup>st</sup> Edition, Vayu Education of India, 2014.
- R3. C. D. Tampo and M. A. Lewis, *Diseases of the Human Body*, 6<sup>th</sup> Edition, F. A. Davis Co., 2016.
- R4. N. A. Campbell, L. A. Urry, M. L. Cain, S. A. Wasserman, P. V. Minorsky, and J. B. Reece, *Biology: A Global Approach*, 10<sup>th</sup> Edition, Pearson Education, 2014.

**Online Resources:**

1. <http://www.dcc-cde.ca.gov/documents/Anita%20Archer%20-%202013/Cell%20Theory.pdf>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3743984/>
3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4239820/>
4. [http://www.euro.who.int/data/assets/pdf\\_file/0013/102316/e79822.pdf](http://www.euro.who.int/data/assets/pdf_file/0013/102316/e79822.pdf)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand different types of cells, list their parts, and describe their structural components and the differences between them.
CO2	Know about metabolism and cell theory.
CO3	Comprehend genetics, organic evolution, and the immune system.
CO4	Identify the cause, symptoms, diagnosis and treatment of common diseases.
CO5	Recognize biological processes like protein synthesis, know about action of enzymes and tissue culture.

**Program Outcomes Relevant to the Course:**

PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2	2	1	2			1	2	1	1
CO2						2	1	1	1			1	2		1
CO3						3	2	1	1			1	2	1	1
CO4						3	2	1	1			1	2		1
CO5						2	2	1	1			1	2	1	1

Type	Code	Professional Ethics & Values	L-T-P	Credits	Marks
MC	18NC1T03			2-0-0	0

<b>Objectives</b>	To enable the students to create an awareness on professional ethics and human values, to instill moral and social values & loyalty to appreciate the rights of others, and to provide the basis for deciding that a particular action is morally good or bad.
<b>Pre-Requisites</b>	Elementary idea on Psychology, sensitivity to professionalism with respect to morality, judgment, and commitment are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, and planned interactive sessions.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction to Ethics: Basic terms – Moral, Values, Ethics, Personal and Professional Ethics, Ethical Dilemma, Resolving Ethical Dilemma, Emotional Intelligence, Moral Development Theories of Kohlberg and Piaget, Views on Ethics by Aristotle, Governing factors of an individual's value system.	<b>6 Hours</b>
<b>Module-2</b>	Profession and Professionalism: Profession, Professional, Professionalism, Professional Accountability, Professional Risks, Conflict of interest, Ethical Theories and their application – Consequentialism, Deontology, Virtue theory, Rights Theory, Casuist theory, Moral Absolutism, Moral Relativism, Moral Pluralism.	<b>9 Hours</b>
<b>Module-3</b>	Ethics in Engineering: Engineering as a profession, Engineers as Managers, Consultants, and Leaders, Engineering as social experimentation, Issues in engineering ethics.	<b>3 Hours</b>
<b>Module-4</b>	Engineers' Responsibility and Safety: Safety and Risk (underestimating, over estimating, indifference), Risk-benefit analysis, Engineers' Responsibility for Safety.	<b>3 Hours</b>
<b>Module-5</b>	Global Ethical Issues: Different ethical issues in Business, Corporate Social Responsibility, Environment, IT, Bioethics, Intellectual Property Rights, Research, and Media.	<b>7 Hours</b>
<b>Total</b>		<b>28 Hours</b>

#### Text Books:

T1. R. Subramanian, *Professional Ethics*, 2<sup>nd</sup> Edition, Oxford University Press, 2017.

#### Reference Books:

- R1. M. W. Martin and R. Schinzinger, *Ethics in Engineering*, Tata McGraw Hill, 2013.  
 R2. C. E. Harris, M. S. Pritchard, and M. J. Rabins, *Engineering Ethics - Concepts and Cases*, Thompson Learning, 2003.  
 R3. D. Albuquerque, *Business Ethics*, Oxford University Press, 2013.  
 R4. E. G. Seebauer and R. L. Barry, *Fundamentals of Ethics*, Oxford University Press, 2012.

R5. R. S. Naagarazan, *A Text Book on Professional Ethics and Human Values*, 2<sup>nd</sup> Edition, New Age International, 2016.

#### Online Resources:

1. <https://india.oup.com/orcs/9780199475070/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Learn ethical concepts which will enable them to effectively resolve ethical issues in their personal and professional lives.
CO2	Be aware of their duties and responsibilities as professionals towards their organization and society.
CO3	Gather primary knowledge on engineering ethics and its objectives, different parameters of enquiry and engineering as an experiment in society.
CO4	Be conscious about risk and safety while finding a solution to an engineering problem.
CO5	Become attentive of the different global ethical issues.

#### Program Outcomes Relevant to the Course:

PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			2			1	1	3				1		3	1
CO2			1			1	1	3	1	1		1		3	1
CO3			1			1		3		1		1		2	1
CO4			1			1	2	3	1			1		2	1
CO5			1			1	1	3	1	1		1		1	1

Type	Code	Digital VLSI Design Lab	L-T-P	Credits	Marks
PC	18EI1L03			0-0-2	1

<b>Objectives</b>	The objective of this laboratory course is to provide hands-on exposure on preparing schematic, layout & simulation of complex digital systems using HDL (Verilog/VHDL) and their implementation on FPGA.
<b>Pre-Requisites</b>	Fundamentals of MOSFET and digital electronics is required. The laboratory experiments shall go along with the topics taught in the theory class.
<b>Teaching Scheme</b>	Regular Laboratory classes with use of ICT as and when required. Practicals are planned to be interactive with focus on problem solving activities and real time applications with the help of software, FPGA and other peripherals.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
<i>Group A: Schematic, Layout and its Simulation (any five)</i>	
1	Design a schematic and simple layout for CMOS Inverter, parasitic extraction and simulation.
2	Design a schematic and simple layout for CMOS NAND gate, parasitic extraction and simulation.
3	Design a schematic and simple layout for CMOS NOR gate, parasitic extraction and simulation.
4	Design a schematic and simple layout for Full adder.
5	Design a schematic and simple layout for MUX, DeMUX.
6	Design a schematic and simple layout for D flip-flop.
7	Design a schematic and simple layout for simple and complex Boolean expressions.
8	Design a schematic and simple layout for dynamic logic implementation (Domino logic).
9	Design a schematic and simple layout for dynamic logic implementation (NORA logic).
10	Design an ALU or a 4-bit Microprocessor with limited instructions.
<i>Group B: HDL (Verilog/VHDL) for Digital Circuits and its Implementation on FPGA (any five)</i>	
11	Design, Test Bench Creation and Simulation of Full Adder and its FPGA Implementation with display of the sum on 7-Segment Display.
12	Design, Test Bench Creation and Simulation of Full Subtractor and its FPGA Implementation with display of the difference on 7-Segment Display.
13	Design, Test Bench Creation and Simulation of 4:1 Mux & 1:4 DeMux and its FPGA Implementation.
14	Design, Test Bench Creation and Simulation of 4 bit up/down Counter and its FPGA Implementation.

*Cont'd...*



Experiment-#	Assignment/Experiment
15	Design, Test Bench Creation and Simulation of 4 bit Shift Register and its FPGA Implementation.
16	Design of ADC & DAC and their FPGA Implementation.
17	Design of Traffic Light Controller and its FPGA Implementation.
18	Design of DC Motor and its FPGA Implementation.
19	Design of Stepper Motor and its FPGA Implementation.
20	Design of Real Time Clock and its FPGA Implementation.

**Text Books:**

- T1. S. -M. Kang and Y. Leblebici, *CMOS Digital Integrated Circuits - Analysis and Design*, 3<sup>rd</sup> Edition, TMH, 2002.
- T2. D. A. Hodges, H. G. Jackson, and R. Saleh, *Analysis and Design of Digital Integrated Circuits in Deep Submicron Technology*, 3<sup>rd</sup> International Edition, McGraw Hill Education, 2004.

**Reference Books:**

- R1. J. P. Rabaey, A. P. Chandrakasan, and B. Nikolić, *Digital Integrated Circuits: A Design Perspective*, 2<sup>nd</sup> Edition, Pearson Education, 2016.
- R2. N. H. E. Weste, D. Harris, and A. Banerjee, *CMOS VLSI Design - A Circuits and Systems Perspective*, 4<sup>th</sup> Edition, Pearson Education, 2010.
- R3. R. J. Baker, *CMOS Circuit Design, Layout, and Simulation*, 3<sup>rd</sup> Edition, John Wiley & Sons, 2010.
- R4. D. A. Pucknell and K. Eshraghian, *Basic VLSI Design*, 3<sup>rd</sup> Edition, PHI Learning, 1995.
- R5. J. P. Uyemura, *Introduction to VLSI Circuits and Systems*, John Wiley & Sons, 2006.
- R6. W. Wolf, *Modern VLSI Design - System on Chip Design*, 3<sup>rd</sup> Edition, Pearson Education, 2004.

**Online Resources:**

1. <http://vlsi-iitg.vlabs.ac.in/>
2. <https://www.edaplayground.com/>
3. <http://cmosedu.com/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the VLSI Design flow from start to finish.
CO2	Design and implement digital systems using different architectures of VHDL.
CO3	Design, implement, and investigate Inverter, combinational, and sequential logic circuits using CMOS technology.
CO4	Implement digital logic circuits in real time using FPGA.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

*Cont'd...*

PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	3	3	1	1				2	1	1		
CO2	1	2	3	2	3								2	1	1
CO3	2	3	3	2	3								2	1	1
CO4	2	2	3	1	3								2	1	1

Type	Code	Digital Signal Processing Lab	L-T-P	Credits	Marks
PC	18EC1L08		0-0-2	1	100

<b>Objectives</b>	The objective of this laboratory course is to perform signal processing operations like convolution, correlation etc., Frequency analysis and implement FIR & IIR filters in MATLAB.
<b>Pre-Requisites</b>	Fundamentals of signals and systems and basics of MATLAB are required. The laboratory experiments shall go along with the topics taught in the theory class.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted under the supervision of the teacher. Demonstration will be given for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Generation of various types of waveforms (sine, cosine, square, triangular etc.) using MATLAB.
2	Linear convolution of sequences (without using the inbuilt conv. function in MATLAB).
3	Computation of autocorrelation of a sequence, cross correlation of two sequences using MATLAB.
4	Computation of the power spectral density of a sequence using MATLAB.
5	Finding the convolution of a periodic sequence using DFT and IDFT in MATLAB.
6	Circular convolution of two sequences and comparison of the result with the result obtained from linear convolution using MATLAB.
7	Convolutions of long duration sequences using overlap add, overlap save using MATLAB.
8	Implementation of FFT algorithm by decimation in time(DIT) and decimation in Frequency(DIF) using MATLAB.
9	Design and implementation of FIR (lowpass and highpass) Filters using windowing techniques (rectangular, triangular, and Kaiser) in MATLAB.
10	Design and implementation of IIR (lowpass and highpass) Filters (Butterworth and Chebyshev) in MATLAB.

#### Text Books:

- T1. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing : Principles, Algorithms and Applications*, 4<sup>th</sup> Edition, Prentice Hall India, 2007.
- T2. A. V. Oppenheim, A. S. Willsky, and S. H. Nawab, *Signals and Systems*, 2<sup>nd</sup> Edition, Prentice Hall India, 1992.
- T3. S. K. Mitra, *Digital Signal Processing : A Computer Based Approach*, 4<sup>th</sup> Edition, McGraw Hill, 2013.

#### Reference Books:

- R1. P. R. Babu, *Digital Signal Processing*, 4<sup>th</sup> Edition, Scitech Publication, 2011.
- R2. R. Pratap, *Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers*, 7<sup>th</sup> Edition, Oxford University Press, 2016.

- R3. S. S. Kumar and S. V. B. Lenina, *MATLAB: Easy Way of Learning*, PHI Learning, 2016.  
 R4. A. N. Kani, *Digital Signal Processing*, 2<sup>nd</sup> Edition, McGraw Hill Education, 2017.

#### Online Resources:

1. <https://nptel.ac.in/courses/108107115/>: by Prof. Y. V. Hote, IIT Roorkee
2. <https://nptel.ac.in/courses/103106118/>: by Prof. N. Kaisare, IIT Madras

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the generation of various elementary signals in MATLAB.
CO2	Analyze basic signal processing operations like convolution, correlation etc.
CO3	Analyze the spectrum of discrete time signals using DFT.
CO4	Implement various efficient computation technique using FFT-DIT and FFT-DIF algorithm.
CO5	Design FIR and IIR filters using various techniques.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	1							2	1	
CO2	2		2	2	1	2							2	1	
CO3	3	2	1		3	2							2	1	
CO4	2	1	3	3	2	3							3	2	1
CO5	3	2	1	1	2	2							2	1	

Type	Code	Skill Lab & Project - I	L-T-P	Credits	Marks
PJ	18EC6L03		0-0-4	2	100

<b>Objectives</b>	The objective of the laboratory course is to additional skills as well as apply the knowledge gained by executing a project in electronics and communication using various hardware/software tools.
<b>Pre-Requisites</b>	Knowledge of basic electronics engineering, analog & digital electronics, microprocessors & microcontrollers, antenna fundamentals, knowledge of analog & digital communication etc., are required.
<b>Teaching Scheme</b>	Regular laboratory classes with the use of different software and hardware tools as per the requirement. Projects shall be executed by guidance & regular interaction with the assigned faculty mentor.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
<i>Software Skills</i>	
1	Introduction to Programming & Simulation software like C, C++, Python etc.
2	Functionality of LED, Photo Diode, Photo Transistor, Sensors, Relays etc. Studying different types of Sources.
3	Using Transistor, MOSFET in various applications, uses of 555 timers.
4	Design of flip-flops and counters of given specifications as per requirements.
5	Study of microprocessors and design of microcontrollers depending on the requirements.
6	Design of Transmitting and Receiving circuit, its analysis, bandwidth, range, noise calculations etc.
<i>Hardware Skills</i>	
1	Design of Power Supply Unit with Rectifiers, Filters and Regulators. (Transformer Design: Shell type, 12-0-12 V, 5A center tapped transformer.)
2	Various applications of image processing like automatic attendance, face recognition etc.
3	Design of Smart Helmet (without which vehicle won't run).
4	Home Automation System.
5	Microcontroller based application design like floor mopping, wheel chair etc.
6	Sensor Based application oriented design like attendance system, Obstacle avoidance, Smart irrigation system etc
7	Applications of Robotics like firefighting, threat detection etc.
<i>Project Work</i>	
1	Software-based Project, presentation & viva-voce
2	Hardware-based Project, presentation & viva-voce

**Text Books:**

- T1. S. Attaway, *MATLAB : A Practical Introduction to Programming and Problem Solving*, 3<sup>rd</sup> Edition, Butterworth-Heinemann, 2013.
- T2. M. Mano and M. D. Ciletti, *Digital Design with an Introduction to Verilog HDL*, 5<sup>th</sup> Edition, Pearson Education, 2013.
- T3. R. L. Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, 11<sup>th</sup> Edition, Pearson Education, 2015.
- T4. A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, 7<sup>th</sup> Edition, Oxford University Press, 2014.
- T5. R. S. Gaonkar, *Microprocessor Architecture, Programming and Applications with the 8085*, 6<sup>th</sup> Edition, Penram International Publishing, 2013.
- T6. H. Taub, D. L. Schilling, and G. Saha, *Principles of Communication Systems*, 4<sup>th</sup> Edition, Tata McGraw-Hill, 2013.

**Reference Books:**

- R1. J. G. Proakis and D. G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 4<sup>th</sup> Edition, Prentice Hall India, 2007.
- R2. B. P. Lathi, Z. Ding, and H. M. Gupta, *Modern Digital and Analog Communication Systems*, 4<sup>th</sup> Edition, Oxford University Press, 2017.

**Online Resources:**

1. <https://nptel.ac.in/courses/117106088/>
2. <https://nptel.ac.in/courses/108107029/>
3. <https://nptel.ac.in/courses/108105102/>
4. <https://nptel.ac.in/courses/108/101/108101092/>
5. <https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Solve a given real life problem relevant to electronics & communication.
CO2	Find an appropriate solution through practical hardware setup or software simulation.
CO3	Present the results of project work comprehensively through proper presentation.
CO4	Prepare comprehensive report of the project with literature survey and future scope.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

*Cont'd...*

PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3				3			3		3	3	2	2	3
CO2	1	2	3	3	3	1	2	1	3	1	2	1	3	1	2
CO3			1	1	1	3	3	2	3	3	1	2	1	3	3
CO4	3	2	1	1	1	1	1	3	3	3	1	3	2	3	3

**Part IV**  
**4th Year B. Tech. (ECE)**



## Curriculum Structure (Regular)

Semester VII								
Type	Code	Course Title	WCH L-T-P			Credits L-T-P		
<b>THEORY</b>								
PC	18EC1T11	Microwave Engineering	3	0	0	3	0	0
PC	18EC1T12	Digital Communication	3	0	0	3	0	0
PE	18**2T**	Professional Elective - III	3	0	0	3	0	0
PE	18**2T**	Professional Elective - IV	3	0	0	3	0	0
PE	18**2T**	Professional Elective - V	3	0	0	3	0	0
OE	18**3T**	Open Elective - III	3	0	0	3	0	0
<b>PRACTICAL</b>								
PC	18EC1L12	Digital Communication Lab	0	0	2	0	0	1
PC	18EC1L11	Emerging Technologies Lab	0	0	2	0	0	1
PJ	18IR6L04	Summer Internship - III	0	0	0	0	0	1
<b>SUB-TOTAL</b>			<b>18</b>	<b>0</b>	<b>4</b>	<b>18</b>	<b>0</b>	<b>3</b>
<b>TOTAL</b>			<b>22</b>			<b>21</b>		

Semester VIII								
Type	Code	Course Title	WCH L-T-P			Credits L-T-P		
<b>THEORY</b>								
PE	18**2T**	Professional Elective - VI	3	0	0	3	0	0
OE	18**3T**	Open Elective - IV	3	0	0	3	0	0
<b>PRACTICAL</b>								
PJ	18IR6L05	Project-II	0	0	16	0	0	8
PJ	18IR6L06	Presentation Skills & Technical Seminar	0	0	4	0	0	2
VV	18VV6L07	Comprehensive Viva	0	0	0	0	0	1
<b>SUB-TOTAL</b>			<b>6</b>	<b>0</b>	<b>20</b>	<b>6</b>	<b>0</b>	<b>11</b>
<b>TOTAL</b>			<b>26</b>			<b>17</b>		

Note: Courses offered under each elective are given in "List of Electives" on Page 189.

**Curriculum Structure (PS-7)**  
 (For Students opting for Practice School / Industry Internship in the 7<sup>th</sup> Semester)

Semester VII								
Type	Code	Course Title	WCH			Credits		
			L-T-P			L-T-P		
<b>PRACTICAL</b>								
PS	18PS6L08	Practice School / Industry Internship	0	0	0	0	0	16
PJ	18IR6L04	Summer Internship - III	0	0	0	0	0	1
		<b>SUB-TOTAL</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>17</b>
		<b>TOTAL</b>	<b>0</b>			<b>17</b>		

Semester VIII								
Type	Code	Course Title	WCH			Credits		
			L-T-P			L-T-P		
<b>THEORY</b>								
PC	18EC1T11	Microwave Engineering	3	0	0	3	0	0
PC	18EC1T12	Digital Communication	3	0	0	3	0	0
PE	18**2T**	Professional Elective - III	3	0	0	3	0	0
PE	18**2T**	Professional Elective - IV	3	0	0	3	0	0
PE	18**2T**	Professional Elective - V	3	0	0	3	0	0
OE	18**3T**	Open Elective - IV	3	0	0	3	0	0
<b>PRACTICAL</b>								
PC	18EC1L12	Digital Communication Lab	0	0	2	0	0	1
PC	18EC1L11	Emerging Technologies Lab	0	0	2	0	0	1
VV	18VV6L07	Comprehensive Viva	0	0	0	0	0	1
		<b>SUB-TOTAL</b>	<b>18</b>	<b>0</b>	<b>4</b>	<b>18</b>	<b>0</b>	<b>3</b>
		<b>TOTAL</b>	<b>22</b>			<b>21</b>		

Note: Subjects under each elective shall be same as those for Regular students (Page 189).

**Curriculum Structure (PS-8)**  
**(For Students opting for Practice School / Industry Internship in the 8<sup>th</sup> Semester)**

<b>Semester VII</b>								
Type	Code	Course Title	WCH L-T-P			Credits L-T-P		
<b>THEORY</b>								
PC	18EC1T11	Microwave Engineering	3	0	0	3	0	0
PC	18EC1T12	Digital Communication	3	0	0	3	0	0
PE	18**2T**	Professional Elective - III	3	0	0	3	0	0
PE	18**2T**	Professional Elective - IV	3	0	0	3	0	0
PE	18**2T**	Professional Elective - V	3	0	0	3	0	0
OE	18**3T**	Open Elective - III	3	0	0	3	0	0
<b>PRACTICAL</b>								
PC	18EC1L12	Digital Communication Lab	0	0	2	0	0	1
PC	18EC1L11	Emerging Technologies Lab	0	0	2	0	0	1
PJ	18IR6L04	Summer Internship - III	0	0	0	0	0	1
<b>SUB-TOTAL</b>			<b>18</b>	<b>0</b>	<b>4</b>	<b>18</b>	<b>0</b>	<b>3</b>
<b>TOTAL</b>			<b>22</b>			<b>21</b>		

<b>Semester VIII</b>								
Type	Code	Course Title	WCH L-T-P			Credits L-T-P		
<b>PRACTICAL</b>								
PS	18PS6L08	Practice School / Industry Internship	0	0	0	0	0	16
VV	18VV6L07	Comprehensive Viva	0	0	0	0	0	1
<b>SUB-TOTAL</b>			<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>17</b>
<b>TOTAL</b>			<b>0</b>			<b>17</b>		

Note: Subjects under each elective shall be same as those for Regular students (Page 189).

### List of Electives

Code	Elective # and Subjects
<b><i>Professional Elective - III</i></b>	
18EI2T27	Analog VLSI Design
18EC2T13	Digital Image & Video Processing
18EC2T63	Speech and Audio Processing
<b><i>Professional Elective - IV</i></b>	
18EC2T39	Embedded System Design
18EC2T23	Adaptive Signal Processing
18EC2T20	Mobile Communication & Networks
<b><i>Professional Elective - V</i></b>	
18EC2T48	Mixed Signal Design
18EC2T28	Antennas & Wave Propagation
18EC2T62	Wireless Sensor Networks
<b><i>Professional Elective - VI</i></b>	
18EC2T42	Fiber Optic Communications
18EC2T57	Satellite Communication Systems
18EI2T31	Bio-Medical Electronics
<b><i>Open Elective - III</i></b>	
18EE3T40	[EEE] Renewable Energy Systems
18BS3T12	[BSH] Stochastic Processes
18BS3T13	[BSH] Project Management
18CS3T15	[CSE] Internet Technology & Applications
18CS3T16	[CSE] Introduction to Machine Learning
18EI3T05	[EIE] Biomedical Instrumentation & Signal Processing
18EI3T17	[EIE] Virtual Instrumentation
<b><i>Open Elective - IV</i></b>	
18EE3T33	[EEE] Energy Studies
18BS3T18	[BSH] Simulation & Modeling
18BS3T20	[BSH] Entrepreneurship Development
18CS3T23	[CSE] Big Data Analytics
18CS3T24	[CSE] Artificial Intelligence
18EI3T25	[EIE] Industrial Instrumentation

Note: Open Electives are choice-based courses offered by other departments as indicated within brackets.

Type	Code	Microwave Engineering	L-T-P	Credits	Marks
PC	18EC1T11			3-0-0	3

<b>Objectives</b>	The objective of this course is to study microwaves, their frequency bands, microwave tubes, amplifiers, components, microwave solid state devices, principles of radar, and scanning & tracking techniques.
<b>Pre-Requisites</b>	Basic knowledge of Circuit Theory, Electromagnetic Theory, and Solid State Physics is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours			
<b>Module-1</b>	<b>Microwave Tubes:</b> Introduction, frequency bands, applications, Conventional tubes - vacuum diode, triode, tetrode, pentode; Limitations of conventional tubes, Reflex Klystron - construction, operation, velocity modulation, power output, efficiency, electronic admittance, Magnetron - construction, operation, cyclotron angular frequency, resonant modes, Hull's cutoff magnetic flux density & cutoff voltage.	<b>9 Hours</b>			
<b>Module-2</b>	<b>Microwave Amplifiers:</b> Klystron Amplifier - construction, operation, reentrant cavities, velocity modulation, output power, beam loading, efficiency, mutual conductance, Travelling Wave Tube (TWT) - Slow wave structures, construction, amplification process.	<b>8 Hours</b>			
<b>Module-3</b>	<b>Microwave Components:</b> Analysis using s-parameters, Junctions (E-Plane, H-Plane, Magic Tee), Directional coupler; Bends and corners; Microwave posts, S. S. tuners, Attenuators, Phase shifter, Ferrite devices (Isolator, Circulator, Gyator); Cavity resonator.	<b>8 Hours</b>			
<b>Module-4</b>	<b>Radar Systems:</b> Principles & operation; Range equation; Pulse repetition frequency (PRF) & range ambiguities; Doppler Radars - Determination of velocity, Continuous Wave (CW) radar and its limitations, Frequency Modulated Continuous Wave (FMCW) radar, Moving Target Indicator (MTI) radar, Delay line cancellers, Blind speeds & staggered PRFs; Scanning & Tracking - horizontal, vertical, spiral, palmer, raster, nodding; Angle tracking systems - Lobe switching, Conical scan, Mono pulse.	<b>9 Hours</b>			
<b>Module-5</b>	<b>Microwave Solid State Devices:</b> Limitations of conventional solid state devices at microwaves; Transistors, Diodes (Tunnel, Varactor, PIN), Transferred electron devices (Gunn diode); Avalanche transit time effect (IMPATT, TRAPATT, SBD); Microwave Amplification by Stimulated Emission of Radiation (MASER).	<b>8 Hours</b>			
<b>Total</b>					<b>42 Hours</b>

#### Text Books:

T1. D. M. Pozar, *Microwave Engineering*, 4<sup>th</sup> Edition, Wiley Publications, 2011.

- T2. S. Liao, *Microwave Devices and Circuits*, 3<sup>rd</sup> Edition, Pearson Education, 2006.  
 T3. M. I. Skolnik, *Introduction to Radar Systems*, 3<sup>rd</sup> Edition, McGraw-Hill Education, 2001.

#### Reference Books:

- R1. G. S. Rao, *Microwave and Radar Engineering*, 1<sup>st</sup> Edition, Pearson Education, 2014.  
 R2. R. E. Collin, *Foundation of Microwave Engineering*, 2<sup>nd</sup> Edition, John Wiley & Sons, 2007.  
 R3. M. Kulkarni, *Microwave Devices and Radar Engineering*, 5<sup>th</sup> Edition, Umesh Publications, 2014.

#### Online Resources:

1. <https://nptel.ac.in/courses/108/101/108101112/>: by Prof. G. Kumar, IIT Bombay
2. <https://nptel.ac.in/courses/108/103/108103141/>: by Prof. R. Bhattacharjee, IIT Guwahati
3. <https://nptel.ac.in/courses/117/105/117105138/>: by Prof. A. Bhattacharya, IIT Kharagpur
4. <https://nptel.ac.in/courses/117/105/117105130/>: by Prof. A. Bhattacharya, IIT Kharagpur
5. <https://nptel.ac.in/courses/117/105/117105122/>: by Prof. A. Bhattacharya, IIT Kharagpur
6. <https://nptel.ac.in/courses/117/101/117101119/>: by Prof. J. Mukherjee, IIT Bombay

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe conventional vacuum tubes, their limitations, microwaves, and their sources.
CO2	Explain the principle of operation of various microwave amplifiers.
CO3	Identify, describe, and explain different microwave components.
CO4	Explain the basic principle of Radar, various scanning and tracking techniques.
CO5	Understand the principle of microwave generation using solid state devices.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	3	1							1	3	1	1
CO2	3	3	1	3	1							1	3	1	1
CO3	2	2	1	3	1							1	2	1	1
CO4	2	3	1	3	1							1	2	1	1
CO5	2	2	1	3	3							1	2	1	1

Type	Code	Digital Communication	L-T-P	Credits	Marks
PC	18EC1T12		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the concepts of digital communication systems covering sampling, aliasing, signal distortion, and different techniques used for waveform coding.
<b>Pre-Requisites</b>	Basics of analog communication and probability & statistics is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Digital Communication Systems:</b> Source, Line coder, Multiplexer, Regenerative repeater, Sampling in transmitting multiple band-limited signals, Signal reconstruction, Quantization of signals (uniform & non-uniform), PCM system, Companding, $\mu$ -law and A-law compression, Input-output characteristics, T1 digital system, Multiplexing T1 lines - The T2, T3 and T4 lines, Line Coding, DPCM, DM and ADM.	<b>9 Hours</b>
<b>Module-2</b>	<b>Noise in PCM and DM:</b> Quantization noise, Output signal power, Thermal noise, Output SNR in PCM, Quantization noise in Delta Modulation, Output signal power, Output SNR, Comparison with PCM and DM; <b>Digital Modulation Techniques:</b> Concept of geometric interpretation of signals, Schwarz's inequality, Concepts of orthogonality and orthonormality, Generation, Transmission, Reception, Spectrum, Geometrical representation and probability of symbol error of ASK, BPSK, DPSK, QPSK, QAM, M-ary PSK, BFSK, M-ary FSK, and Minimum Shifting Keying (MSK).	<b>9 Hours</b>
<b>Module-3</b>	<b>Signal Detection:</b> A base band signal receiver, Peak signal to RMS noise output voltage ratio, Probability of error, Optimum threshold, Optimum receiver (base band & pass band), Optimum filter transfer function, Optimum filter realization using Matched filter, Probability error of the matched filter, Optimum filter realization using correlator and ML Detector.	<b>8 Hours</b>
<b>Module-4</b>	<b>Principle of Digital Data Transmission:</b> Line Coding - PSD of various line codes, Polar signaling, Constructing a DC Null in PSD by pulse shaping, On Off signaling, Bipolar signaling; Pulse shaping – ISI and effect, Nyquist first criterion for zero ISI; Scrambling, Digital receiver, Equalizers, Timing extraction, Detection error and Eye Diagram.	<b>8 Hours</b>
<b>Module-5</b>	<b>Multiple Access Techniques:</b> FDMA, TDMA, CDMA, OFDM, OFDM transmitter and receiver, Orthogonality of sub-carriers, Concept of cyclic prefix, OFDM block-diagram, MIMO system, MIMO system solutions, MIMO system model, MIMO capacity on Fading channels.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. H. Taub, D. L. Schilling, and G. Saha, *Principles of Communication Systems*, 4<sup>th</sup> Edition, McGraw Hill Education, 2013.
- T2. B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4<sup>th</sup> Edition, Oxford University Press, 2010.
- T3. S. Haykin, *An Introduction to Analog and Digital Communications*, 2<sup>nd</sup> Edition, John Wiley & Sons, 2007.

**Reference Books:**

- R1. L. W. Couch II, *Digital and Analog Communication Systems*, 8<sup>th</sup> Edition, Pearson Education, 2013.
- R2. B. Sklar, *Digital Communication - Fundamentals and Applications*, 2<sup>nd</sup> Edition, Pearson Education, 2009.

**Online Resources:**

1. <https://nptel.ac.in/courses/108/102/108102096/>: by Prof. S. Prasad, IIT Delhi
2. <https://nptel.ac.in/courses/108/101/108101113/>: by Prof. S. N. Merchant, IIT Bombay
3. <https://nptel.ac.in/courses/108/102/108102120/>: by Prof. A. Dixit, IIT Delhi

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the sampling theorem, practical issues related to sampling, signal reconstruction, quantization, encoding along with applications.
CO2	Apply digital modulation & demodulation techniques considering bandwidth, SNR and power spectral efficiency.
CO3	Design optimum receivers for pass band and base band communications and compare the performance of correlator receiver with matched filter reception.
CO4	Visualize practical issues related to digital data transmissions such as pulse shaping, line coding, repeater circuits, equalizer and timing extraction.
CO5	Describe different types of multiple access techniques, OFDM transmission and reception along with MIMO System.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

*Cont'd...*



PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2							1	2	1	1
CO2	3	3	3	2	3	3						1	3	2	1
CO3	3	3	3	2	3	2							3	1	
CO4	3	2	2	3	2	2							2	1	
CO5	3	3	1	2	3	1						1	2	2	1

Type	Code	Analog VLSI Design	L-T-P	Credits	Marks
PE	18EI2T27			3-0-0	3

<b>Objectives</b>	The objective of this course is to study analysis & design of analog integrated circuits and systems for various applications including single-stage, differential & operational amplifiers, current mirrors & bandgap reference circuits with different specifications.
<b>Pre-Requisites</b>	Fundamentals of MOSFET, analog electronics, and network theory are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Review of Circuits &amp; Systems:</b> Circuit elements and their constitutive relations; Network theory: Superposition (Linearity) and Time-Invariant principle; Design and analysis of LTI systems: KCL, KVL, Node Equation procedure, Thevenin and Norton method; Matrix formulation for CAD solution; Analysis of non-linear circuits: analytical, graphical and incremental solution; Dynamic Circuit Analysis: Solution to first-order differential equation.	<b>4 Hours</b>
<b>Module-2</b>	<b>Integrated Circuit Devices:</b> Diodes - Basic operation & Large-signal modeling; MOS Transistor: Large & small-signal (low & high frequency) modeling, Advanced MOS modeling (subthreshold, mobility degradation); <b>Introduction to SPICE modeling:</b> Diode Model, MOS Transistors, Advanced SPICE Models for MOS Transistors; Passive Devices: Resistors and capacitors; Reading process parameters from foundry documents.	<b>9 Hours</b>
<b>Module-3</b>	<b>CMOS Processing &amp; Layout:</b> CMOS processing, Layout and design rules; Reading design rules from foundry documents; Analog layout considerations - variability, mismatch, matching, noise consideration. <b>Single-Stage Amplifiers:</b> Common-Source, Source Follower, Common-Gate, Examples, Impedance Matching.	<b>10 Hours</b>
<b>Module-4</b>	<b>Op-Amp:</b> Diff-Amp, Telescopic, Folded Cascode, Two-Stage Amplifier Design; Stability: Frequency Response, Feedback, Compensation. Current Mirrors: Simple current mirror, Cascode current mirror, Wide-swing current mirror, Matching.	<b>10 Hours</b>
<b>Module-5</b>	<b>Bandgap References:</b> Low Power Bandgap Reference Design. <b>Low Noise Amplifier (LNA):</b> Design of Low Noise Amplifier.	<b>9 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. T. C. Carusone, D. A. Johns, and K. A. Martin, *Analog Integrated Circuit Design*, 2<sup>nd</sup> Edition, Wiley India, 2012.

- T2. B. Razavi, *Design of Analog CMOS Integrated Circuits*, Indian Edition, McGraw-Hill Education, 2002.
- T3. D. Holberg and P. Allen, *CMOS Analog Circuit Design*, 3<sup>rd</sup> Edition, Oxford University Press, 2013.
- T4. N. Weste and D. Harris, *CMOS VLSI Design: A Circuits and Systems Perspective*, 4<sup>th</sup> Edition, Pearson Education, 2015.

#### Reference Books:

- R1. P. Gray, P. Hurst, S. Lewis, and R. Meyer, *Analysis and Design of Analog Integrated Circuits*, 4<sup>th</sup> Edition, John Wiley & Sons, 2001.
- R2. R. J. Baker, *CMOS Circuit Design, Layout and Simulation*, IEEE Inc., 2008.
- R3. A. Sedra and K.C. Smith, *Microelectronic Circuits*, 5<sup>th</sup> Edition, Oxford University Press, 2004.
- R4. W. M. Siebert, *Circuits, Signals, and Systems*, 1<sup>st</sup> Edition, MIT Press, 1986.
- R5. A. Agarwal and J. Lang, *Foundations of Analog and Digital Electronic Circuits*, 1<sup>st</sup> Edition, Elsevier, 2005.

#### Online Resources:

1. <http://cmosedu.com>
2. <http://pages.hmc.edu/harris/>
3. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/>
4. <https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-374-analysis-and-design-of-digital-integrated-circuits-fall-2003/>
5. <https://nptel.ac.in/courses/117/101/117101105/>
6. <https://nptel.ac.in/courses/117106030/>
7. <https://nptel.ac.in/courses/108/106/108106105/>
8. <https://nptel.ac.in/courses/108/106/108106068/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the structure and operational analysis of devices like Diode, MOSFET and their large and small-signal models, design flow and fabrication steps.
CO2	Describe the CMOS process and layout design for Analog Integrated Circuits.
CO3	Design single-stage amplifiers for various applications.
CO4	Design Op-Amps and current mirrors of different topologies for various applications.
CO5	Analyze and design bandgap reference and low noise amplifiers.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Cont'd...

PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1		1							1	1		
CO2	1	1		1	2							1	1		
CO3	2	2	3	1		1							2	1	1
CO4	2	3	3	2		1							2	1	1
CO5	2	3	3	2		1							2	1	1

Type	Code	Digital Image & Video Processing	L-T-P	Credits	Marks
PE	18EC2T13		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the fundamentals, transformation, filtering, restoration, compression, and segmentation of images & videos, and their applications in various real life problems.
<b>Pre-Requisites</b>	Basics of matrices, 1-D convolution & filters, DSP, DFT, DCT, etc. are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Image Fundamentals:</b> Fundamental steps in digital image processing, Image sensing and acquisition, Image formation model. Image sampling and quantization, Spatial and intensity resolution, Image Interpolation, Relationship between pixels, Distance measure. <b>Basic Intensity Transformation Functions:</b> Image negative, Log transformation, Power-law transformations, Piecewise linear transformation functions, Contrast stretching, Intensity-level slicing, Bit-plane slicing, Histogram Processing, Histogram equalization.	<b>8 Hours</b>
<b>Module-2</b>	<b>Spatial &amp; Frequency Domain Filters:</b> Mechanics of spatial filtering, Spatial correlation and convolution, Smoothing spatial filters, Sharpening spatial filters, Unsharp masking and high-boost filtering, Filtering in frequency domain, Image smoothing and sharpening in frequency domain using ideal, Butterworth, Gaussian, and Homomorphic filters.	<b>8 Hours</b>
<b>Module-3</b>	<b>Image Restoration:</b> A model of image degradation / restoration process, Noise models, Restoration in the presence of noise, Order statistics filters, Adaptive filters, Linear position invariant degradations, Estimating the degradation function, inverse filtering, Wiener filter, Constrained least square filter. <b>Color Image Processing:</b> Color fundamentals, Color models, Color conversions, Pseudo-color processing, Basics of full color image processing.	<b>8 Hours</b>
<b>Module-4</b>	<b>Image Segmentation:</b> Point, line and edge detection, Edge linking and boundary detection, Global processing using Hough transform, Thresholding, Global, adaptive and region-based segmentation. <b>Image Compression:</b> Fundamentals, Redundancy, Entropy, Some basic compression methods, Huffman coding, Arithmetic coding, LZW coding, Block transform coding, Predictive coding, Lossy predictive coding, Still image compression standards – JPEG and JPEG-2000.	<b>9 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Video Coding:</b> Inter-frame redundancy, Motion estimation techniques – full search, fast search, Forward and backward motion prediction, Frames, Slices, Macro-blocks and blocks, Frame classification – I, P and B; Video sequence hierarchy – Group of pictures; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X. <b>Video Segmentation:</b> Temporal segmentation – Shot boundary detection, Hard and Soft-cuts; Motion-based spatial segmentation; Video object detection & tracking.	9 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 3<sup>rd</sup> Edition, Pearson Education, 2008.
- T2. M. Tekalp, *Digital Video Processing*, 2<sup>nd</sup> Edition, Prentice Hall of India, 2015.

**Reference Books:**

- R1. A. K. Jain, *Fundamentals of Digital Image Processing*, 2<sup>nd</sup> Edition, Prentice Hall of India, 2004.
- R2. S. Sridhar, *Digital Image Processing*, 2<sup>nd</sup> Edition, Oxford University Press, 2014.
- R3. A. L. Bovik, *A Handbook of Image and Video Processing*, 2<sup>nd</sup> Edition, Academic Press, 2000.
- R4. S. Jayaraman, S. Esakkirajan, and T. Veerakumar, *Digital Image Processing*, 2<sup>nd</sup> Edition, McGraw-Hill Education, 2013.

**Online Resources:**

1. <https://nptel.ac.in/courses/117105079/>: by Prof. P. K. Biswas, IIT Kharagpur
2. <https://nptel.ac.in/courses/117105135/>: by Prof. P. K. Biswas, IIT Kharagpur
3. <https://nptel.ac.in/courses/106105032/>: by Dr. G. Harit, IIT Kharagpur
4. <https://nptel.ac.in/courses/117/104/117104069/>: by Prof. S. Gupta, IIT Kanpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe fundamental concepts of image processing, its scope and applications.
CO2	Explain 2D convolution in spatial & frequency domain and their implications in developing various high-pass & low-pass filters.
CO3	Restore images using various schemes & adaptive filters and process color images.
CO4	Segment and compress images using various techniques as per application requirement.
CO5	Perform video coding and segmentation using various techniques & standards.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

*Cont'd...*

PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	2							1	2		1
CO2	3	2	2	2	2							1	2		1
CO3	2	2	1	2	2							2	2		1
CO4	2	1	1	1	2							1	2		1
CO5	1	1	2	2	2							2	2		1

Type	Code	Speech & Audio Processing	L-T-P	Credits	Marks
PE	18EC2T63		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the properties & quality of speech signals, and their processing like separation, recognition, coding, synthesis etc., for wireless communication.
<b>Pre-Requisites</b>	Basic knowledge about digital signal processing is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT, audio & video tools as required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Speech production and modeling, Human auditory system; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid; Requirements of speech codecs – quality, coding delays, robustness.	<b>8 Hours</b>
<b>Module-2</b>	<b>Speech Signal Processing:</b> Pitch-period estimation, All-pole and All-zero filters, convolution; Power spectral density, Periodogram, Autoregressive model, Autocorrelation estimation.	<b>8 Hours</b>
<b>Module-3</b>	<b>Linear Prediction of Speech:</b> Basic concepts of Linear Prediction, Linear Prediction Analysis of non-stationary signals – prediction gain, examples; Levinson-Durbin algorithm, Long term and short-term linear prediction models, Moving average prediction; <b>Speech Quantization:</b> Scalar quantization – uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.	<b>9 Hours</b>
<b>Module-4</b>	<b>Scalar Quantization of LPC:</b> Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Linear Prediction Coding - LPC model of speech production, Structures of LPC encoders and decoders, Voicing detection, Limitations of the LPC model.	<b>9 Hours</b>
<b>Module-5</b>	<b>Code Excited Linear Prediction:</b> CELP speech production model, Analysis-by-synthesis, Generic CELP encoders and decoders, Excitation codebook search – state-save method, CELP based on adaptive codebook, Adaptive codebook search, Low delay CELP and algebraic CELP.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. A. M. Kondoz, *Digital Speech*, 2<sup>nd</sup> Edition, Wiley Students Edition, 2004.
- T2. W. C. Chu, *Speech Coding Algorithms: Foundation & Evolution of Standardized Coders*, Wiley Inter Science, 2003.

#### Reference Books:

- R1. L. Rabiner, B. -H. Juang, and B. Yegnanarayana, *Fundamentals of Speech Recognition*, 1<sup>st</sup> Edition, Pearson Education, 2009.



R2. D. O. Shaughnessy, *Speech Communications - Human and Machine*, 2<sup>nd</sup> Edition, IEEE Press, 2012.

#### Online Resources:

1. <https://nptel.ac.in/courses/117105145/>: by Prof. S. K. D. Mandal, IIT Kharagpur
2. [https://www.ece.ucsb.edu/Faculty/Rabiner/ece259/digital%20speech%20processing%20course/lectures\\_new/Lecture\\_algorithms\\_fall\\_2010.pdf](https://www.ece.ucsb.edu/Faculty/Rabiner/ece259/digital%20speech%20processing%20course/lectures_new/Lecture_algorithms_fall_2010.pdf)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain different speech production systems, coding techniques, and codecs.
CO2	Describe pitch and power of speech signals and processing of the same.
CO3	Visualize linear prediction methods and different types of quantizers for speech signals.
CO4	Describe the LPC model and the structure of encoders & decoders.
CO5	Analyze and synthesize CELP speech production model.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	1	2					1	3	1	1
CO2	3	3	2	3	2	1	1					1	3	1	1
CO3	3	3	2	3	1	2							3	1	
CO4	2	2	2	2	1	1							2	1	
CO5	2	2	3	1	1	1							2	1	

Type	Code	Embedded System Design	L-T-P	Credits	Marks
PE	18EC2T39			3-0-0	3

<b>Objectives</b>	The objective of this course is to study the components, programming, integration, and life cycle management of hardware & firmware to design & develop embedded systems for real-world applications.
<b>Pre-Requisites</b>	Knowledge of microprocessor & microcontrollers, basic electronics, digital electronic circuits and operating systems is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Embedded Systems, Processor embedded into a system, Embedded hardware units and devices, Embedded software, Examples, Embedded SoC and use of VLSI, Design process and examples, Classification of embedded systems, Skills required for a designer; Typical Embedded System: Core, Memory, Sensors & Actuators, Communication interface, Embedded firmware.	<b>8 Hours</b>
<b>Module-2</b>	<b>Characteristic &amp; Quality Attributes:</b> Application and domain specific embedded systems; Designing with Microcontrollers, Factors to consider for selecting a controller; <b>Hardware Software Co-Design and Program Modeling:</b> Fundamental issues in Hardware Software Co-Design, Computational models in embedded design, Introduction to UML, Hardware Software Trade-offs.	<b>9 Hours</b>
<b>Module-3</b>	<b>Embedded Hardware Design &amp; Development:</b> Analog Electronic Components, Digital Electronic Components, VLSI and Integrated Circuit Design, Electronic Design Automation (EDA) Tools; Embedded Firmware Design & Development: Design Approaches, Development Languages.	<b>8 Hours</b>
<b>Module-4</b>	<b>Real Time Operating System (RTOS) based Design:</b> Operating system basics, Types of operating systems, Tasks, Process & Threads, Multiprocessing & Multitasking, Task Scheduling, Task Communication, Task Synchronization, Choosing an RTOS.	<b>8 Hours</b>
<b>Module-5</b>	<b>Integration &amp; Testing:</b> Integration of Hardware & Firmware, Board Power up; Embedded System Development Environment: Integrated Development Environment (IDE), Types of files generated on cross-compilation, Disassembler/Decompiler, Simulators, Emulators & Debugging, Target Hardware Debugging; <b>Product Enclosure Design &amp; Development:</b> Tools, Development Techniques, Embedded Product Development Life Cycle (EDLC): Definition and Objectives of EDLC, Phases of EDLC, EDLC Approaches (Modeling the EDLC).	<b>9 Hours</b>
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. K. V. Shibu, *Introduction to Embedded Systems*, 1<sup>st</sup> Edition, Tata McGraw-Hill, 2009.
- T2. R. Kamal, *Embedded Systems – Architecture, Programming and Design*, 12<sup>th</sup> Edition, Tata McGraw-Hill, 2007.

**Reference Books:**

- R1. D. E. Simon, *An Embedded Software Primer*, 1<sup>st</sup> Edition, Addison Wesley, 1999.
- R2. J. Ganssle, *The Art of Designing Embedded Systems*, 2<sup>nd</sup> Edition, Elsevier, 2008.
- R3. K. Short, *Embedded Microprocessor System Design*, 1<sup>st</sup> Edition, Prentice Hall, 1998.
- R4. C. Baron, J. Geffroy, and G. Motet (Eds), *Embedded System Applications*, Springer, 1997.
- R5. D. Gajski, *Embedded System Design: Modeling, Synthesis and Verification*, Springer, 2009.

**Online Resources:**

1. <https://nptel.ac.in/courses/106105159/>: by Prof. A. Basu, IIT Kharagpur
2. <https://nptel.ac.in/courses/108102045/>: by Prof. S. Chaudhary, IIT Delhi

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the fundamental building blocks of a typical embedded system.
CO2	Explain the quality attributes of embedded systems and the co-design approach for embedded hardware and firmware development.
CO3	Explain the elements of embedded hardware and their design principles and development steps.
CO4	Understand the need for an operating system and internals of RTOS based embedded firmware design.
CO5	Integrate, test, and manage an embedded system development life cycle (EDLC).

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

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PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO10	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1		1						2	3	1		2
CO2	3	2	3		1		2			1	2	2	2	1	2
CO3	1	2	1	1	1		1				3	2	1	1	2
CO4	2	1	1	1	2	1					2	3	1	1	2
CO5	2	3	3	1	2	1	1			2	2	2	3	1	2

Type	Code	Adaptive Signal Processing	L-T-P	Credits	Marks
PE	18EC2T23		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the theory of adaptive systems, recursive & non-recursive algorithms for different adaptive problems, and their applications to adaptive systems.
<b>Pre-Requisites</b>	Basic knowledge of mathematics, trigonometry, probability & statistics, and signals & systems is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
Module-1	<b>Introduction:</b> Adaptive Systems – Definition and characteristics, General properties, Open and Closed Loop Adaptations, Applications.	7 Hours
Module-2	<b>The Adaptive Linear Combiner:</b> Performance function, Gradient and Mean Square Error, Examples. <b>Theory of Adaptation with Stationary Signals:</b> Properties of the Quadratic Performance Surface, Significance of eigen values, eigen vectors, correlation matrix.	9 Hours
Module-3	<b>Searching the Performance Surface:</b> A simple gradient search algorithm, Stability and Rate of convergence, the learning curve. <b>Gradient Estimation and its Effects on Adoption:</b> The performance penalty, Variance of the gradient estimate, Maladjustment.	9 Hours
Module-4	<b>Adaptive Algorithms and Structures:</b> The LMS Algorithm, Convergence, learning Curve, Performance analysis, Filtered X LMS algorithm.	8 Hours
Module-5	<b>Applications:</b> Adaptive Modeling and System Identification using adaptive filter, Inverse Adaptive Modeling, De-convolution, and equalization using adaptive filter.	9 Hours
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

T1. B. Widrow and S. D. Stearns, *Adaptive Signal Processing*, 2<sup>nd</sup> Edition, Pearson Education, 2009.

#### Reference Books:

R1. S. Haykin, *Adaptive Filter Theory*, 4<sup>th</sup> Edition, Pearson Education, 2008.

#### Online Resources:

1. <https://nptel.ac.in/courses/117/105/117105075/>: by Prof. M. Chakraborty, IIT Kharagpur

P.T.O

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Use probability theory to comprehend design criteria and model adaptive systems.
CO2	Develop mathematical model of linear adaptive processors for performance & stability.
CO3	Use gradient search algorithm for gradient estimation for adaptive systems.
CO4	Apply LMS algorithm for estimating the filter weight & performance analysis.
CO5	Apply various filtering techniques to a given problem and assess the solution & results.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2							1	3	1	1
CO2	3	3	3	2	2							1	3	1	1
CO3	3	3	3	2	2							1	3	1	1
CO4	3	3	3	3	3							1	3	1	1
CO5	3	2	3	3	3	1	1					1	3	2	1

Type	Code	Mobile Communication & Networks	L-T-P	Credits	Marks
PE	18EC2T20		3-0-0	3	100

<b>Objectives</b>	The objectives of this course is to study the concepts of communication networks, wireless communication with its challenges & developments, wireless application protocols & standards, and Bluetooth technology.
<b>Pre-Requisites</b>	Basic knowledge of computer networking & wireless transmission is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on examples and latest trends.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours			
<b>Module-1</b>	<b>Communication Networks:</b> LANs, MANs, WANs, Switching techniques, Wireless ATM networks, TCP/IP protocol architecture, OSI protocol architecture, Internetworking.	<b>8 Hours</b>			
<b>Module-2</b>	<b>Wireless Communication Technology:</b> Propagation modes, LOS transmission, Fading in the mobile environment, Free-space Attenuation, Attenuation over Reflecting Surfaces, Radio wave Propagation, Propagation Path-loss Models, Cost 231 Model.	<b>8 Hours</b>			
<b>Module-3</b>	<b>Cellular Wireless Networks:</b> Principles of cellular network, first, second and third Generation systems. Mobile IP and wireless Access Protocol: Mobile IP, Wireless Application Protocol, Internet control message protocol, Message authentication, Service primitives and parameters.	<b>9 Hours</b>			
<b>Module-4</b>	<b>Wireless LAN Technology:</b> Overview, Infrared LANs, Spread spectrum LANs, Narrowband microwave LANs. IEEE 802.11 Wireless LAN: IEEE 802 protocol architecture, IEEE 802.11 architecture and services, IEEE 802.11 MAC, IEEE 802.11 physical layer.	<b>9 Hours</b>			
<b>Module-5</b>	<b>Bluetooth:</b> Overview, Radio specification, baseband specification, Link manager specification, Logical Link control and adaptation protocol; Wi-MAX standards, Wi-Fi standards, Zig-bee.	<b>8 Hours</b>			
<b>Total</b>					<b>42 Hours</b>

#### Text Books:

- T1. U. Dalal, *Wireless Communication and Networks*, 1<sup>st</sup> Edition, Oxford University Press, 2015.
- T2. I. S. Misra, *Wireless Communication and Networks: 3G and Beyond*, 2<sup>nd</sup> Edition, McGraw-Hill Education, 2017.

#### Reference Books:

- R1. V. K. Garg, *Wireless Communication and Networking: Essential Reading*, Morgan Kaufman, 2008.
- R2. T. S. Rappaport, *Wireless Communications*, 2<sup>nd</sup> Edition, Pearson Education, 2010.
- R3. D. Tse and P. Viswanath, *Fundamentals of Wireless Communication*, Cambridge University Press, 2005.

**Online Resources:**

1. <https://nptel.ac.in/courses/106/105/106105082/>: by Prof. A. Pal, IIT Kharagpur
2. <https://nptel.ac.in/courses/106/108/106108098/>: by Prof. H.S. Jamadagni, IISc Bangalore
3. <https://nptel.ac.in/courses/106/105/106105081/>: by Prof. S. Ghosh, IIT Kharagpur
4. <https://nptel.ac.in/courses/106/105/106105183/>: by Prof. S. Chakraborty and Prof. S. K. Ghosh, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the fundamentals of mobile communication networks and various protocols.
CO2	Analyze radio propagation, fading, attenuation, channel modeling and other path losses.
CO3	Explain & compare various wireless application protocols & mobile IP implementations.
CO4	Use internet from remote location for multiple access signal structuring.
CO5	Multiplex higher layer protocols and design wi-fi infrastructure.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	1								2		
CO2	3	3	2	3	2							1	3		1
CO3	3	2	3	3	3								3		
CO4	3	3	2	2	2							1	2		1
CO5	3	3	3	3	3								3		



Type	Code	Mixed Signal Design	L-T-P	Credits	Marks
PE	18EC2T48			3-0-0	3

<b>Objectives</b>	The objective of this course is to study the inter-conversion of analog & digital signals, design of systems involving mixed signals, and their practical applications in various fields.
<b>Pre-Requisites</b>	Basic knowledge of signal processing, and analog & digital communication techniques is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Analog &amp; Discrete-time Signal Processing:</b> Introduction to sampling theory; Time Domain Description of Reconstruction, The Sample-and-Hold (S/H) Spectral Response, The Reconstruction Filter (RCF); Analog Continuous Time Filters: Passive and Active Filters; Basics of Analog Discrete-time Filters and Z-Transform.	<b>9 Hours</b>
<b>Module-2</b>	<b>Switched-Capacitor Filters:</b> Nonidealities in switched-capacitor filters; Switched-capacitor filter architectures; Switched-capacitor filter applications.	<b>8 Hours</b>
<b>Module-3</b>	<b>Analog to Digital Converters:</b> Basics of data converters, Successive approximation ADCs, Dual slope ADCs, Flash ADCs, Pipeline ADCs, Hybrid ADC structures, High-resolution ADCs, DACs.	<b>9 Hours</b>
<b>Module-4</b>	<b>Mixed-signal Layout:</b> Interconnects and data transmission; Voltage-mode signalling and data transmission; Current-mode signaling and data transmission.	<b>8 Hours</b>
<b>Module-5</b>	<b>Frequency Synthesizers &amp; Synchronization:</b> Basics of PLL, Analog PLLs; Digital PLLs; DLLs.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. R. J. Baker, *CMOS Mixed-Signal Circuit Design*, Wiley India, IEEE Press, 2008.
- T2. B. Razavi, *Design of Analog CMOS Integrated Circuits*, 1<sup>st</sup> Edition, McGraw-Hill Education, 2003.

#### Reference Books:

- R1. R. V. dePlassche, *CMOS Integrated ADCs and DACs*, Indian Edition, Springer, 2005.
- R2. A. B. Williams, *Electronic Filter Design Handbook*, McGraw-Hill Education, 1981.
- R3. R. Schaumann and M. E. V. Valkenburg, *Design of Analog Filters*, Oxford University Press, 2008.
- R4. R. J. Baker, *CMOS Circuit Design: Layout and Simulation*, 2<sup>nd</sup> Rev. Edition, IEEE Press, 2008.

P.T.O

**Online Resources:**

1. <https://nptel.ac.in/courses/117105143/>
2. [https://nptel.ac.in/content/storage2/nptel\\_data3/html/mhrd/ict/text/117105143/lec60.pdf](https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/117105143/lec60.pdf)
3. <http://www.digimat.in/nptel/courses/video/117105143/L22.html>
4. <http://www.nptelvideos.in/2012/11/communication-engineering.html>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Apply various techniques for processing of analog and discrete-time signals.
CO2	Design switched-capacitor filters for various mixed-signal applications.
CO3	Convert analog signals to digital form and vice versa.
CO4	Describe voltage and current mode signaling and data transmission in mixed-signal layout.
CO5	Differentiate between various types frequency synthesizers.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1							1	2		1
CO2	3	3	1	1	1							1	2		1
CO3	3	3	1	1	1							1	2		1
CO4	3	3	1	3	3								3		
CO5	3	2	3	3	3	1	1						3		

Type	Code	Antennas & Wave Propagation	L-T-P	Credits	Marks
PE	18EC2T28		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the principle of electromagnetic radiation, different types of antennas with their working principles and wave propagation characteristics.
<b>Pre-Requisites</b>	Knowledge of network theory and electro-magnetic theory is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as needed; sessions are planned to be interactive with focus on working principle of different antennas.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Fundamental Parameters of Antennas:</b> Radiation pattern, Beam solid angle, Directivity, Gain, Input impedance, Polarization, Bandwidth, Reciprocity, Equivalence of Radiation patterns, Equivalence of Impedances, Effective aperture, Vector effective length, Antenna temperature.	<b>8 Hours</b>
<b>Module-2</b>	<b>Electromagnetic Radiation:</b> Review of electromagnetic theory - Vector potential, Solution of wave equation, Retarded case, Hertzian dipole.	<b>8 Hours</b>
<b>Module-3</b>	<b>Wire Antennas:</b> Short dipole, Radiation resistance and Directivity, Half Wave Dipole, Monopole, Small loop antennas; <b>Antenna Arrays:</b> Linear Array and Pattern Multiplication, Two-element Array, Uniform Array, Polynomial representation, Array with non-uniform Excitation - Binomial Array.	<b>9 Hours</b>
<b>Module-4</b>	<b>Aperture Antennas:</b> Magnetic current and its fields, Uniqueness theorem, Field equivalence principle, Duality principle, Method of Images, Pattern properties, Slot antenna, Horn antenna, Pyramidal horn antenna, Reflector antennas - Flat reflector, Corner reflector, Common curved reflector shapes, Lens antenna.	<b>8 Hours</b>
<b>Module-5</b>	<b>Special Antennas:</b> Long wire, V and Rhombic antenna, Yagi-Uda antenna, Turnstile antenna, Helical antennas - Axial mode helix, Normal mode helix, Biconical antenna, Log periodic dipole array, Spiral antenna, Microstrip patch antennas. <b>Antenna Measurements:</b> Radiation pattern measurement, Gain and directivity measurements, Anechoic chamber measurement.	<b>9 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. C. A. Balanis, *Antenna Theory : Analysis and Design*, 4<sup>th</sup> Edition, John Wiley & Sons, 2016.
- T2. A. R. Harish and M. Sachidanada, *Antennas and Wave Propagation*, 1<sup>st</sup> Edition, Oxford University Press, 2007.

#### Reference Books:

- R1. J. D. Kraus, R. J. Marhefka, and A. S. Khan, *Antennas for All Applications*, 3<sup>rd</sup> Edition, Tata McGraw-Hill, 2002.

- R2. R. C. Johnson and H. Jasik, *Antenna Engineering Hand Book*, 3<sup>rd</sup> Edition, McGraw-Hill, 1993.  
 R3. I. J. Bhal and P. Bhartia, *Micro-strip Antennas*, 2<sup>nd</sup> Edition, Artech House, 1980.

#### Online Resources:

1. <https://nptel.ac.in/courses/108/105/108105114/>: by Dr. A. Bhattacharya, IIT Kharagpur
2. <https://nptel.ac.in/courses/108/101/108101092/>: by Prof. G. Kumar, IIT Bombay
3. <https://nptel.ac.in/courses/117/107/117107035/>: Dr. A. Patnaik, IIT Roorkee
4. <https://nptel.ac.in/content/storage2/courses/108101092/Antennas-Course-Outline-16Aug2016.pdf>: Slides by Prof. G. Kumar, IIT Bombay

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain fundamental parameters of antennas and their implications.
CO2	Formulate mathematical model for electric & magnetic fields of various antennas.
CO3	Design antenna arrays and analyze their radiation patterns.
CO4	Describe principles & radiation mechanisms of various antennas with their applications.
CO5	Measure the antenna parameters and describe features of special antennas.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1							2	2		1
CO2	3	3	1	3	1							2	3		1
CO3	3	3	1	3	1							1	3		1
CO4	3	3	1	3	1							2	3		1
CO5	3	3	1	3	3							1	3		1

Type	Code	Wireless Sensor Networks	L-T-P	Credits	Marks
PE	18EC2T62			3-0-0	3

<b>Objectives</b>	The objective of this course is to study the concepts of wireless sensor networks with their architecture, design principles, protocols, and practical challenges along with localization and positioning techniques.
<b>Pre-Requisites</b>	Basic knowledge of wireless communication is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on examples and practical applications.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
Module-1	<b>Sensor Network Concept:</b> Introduction, Networked wireless sensor devices, Advantages of Sensor networks, Applications, Key design challenges.	6 Hours
Module-2	<b>Network Deployment:</b> Structured versus randomized deployment, Network topology, Connectivity, Connectivity using power control, Coverage metrics, Mobile deployment.	8 Hours
Module-3	<b>Localization and Tracking:</b> Issues and approaches, Problem formulations - Sensing model, collaborative localization, Coarse-grained and Fine-grained node localization, Tracking multiple objects.	10 Hours
Module-4	<b>Wireless Communications:</b> Link quality, shadowing and fading effects. <b>Medium-access &amp; Sleep Scheduling:</b> Traditional MAC protocols, Energy efficiency in MAC protocols, Asynchronous sleep techniques, Sleep-scheduled techniques, and Contention-free protocols.	10 Hours
Module-5	<b>Routing:</b> Metric-based approaches, Multi-path routing, Lifetime-maximizing energy-aware routing techniques, Geographic routing. <b>Sensor Network Databases:</b> Data-centric routing, Data-gathering with compression.	8 Hours
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. F. Zhao and L. Guibas, *Wireless Sensor Networks: An Information Processing Approach*, 3<sup>rd</sup> Edition, Morgan Kaufmann, 2004.

#### Reference Books:

- R1. B. Krishnamachari, *Networking Wireless Sensors*, 1<sup>st</sup> Edition, Cambridge University Press, 2005.  
 R2. C. S. Raghavendr, M. K. Sivalingam, and T. Znati, *Wireless Sensor Networks*, 1<sup>st</sup> Edition, Springer, 2006.  
 R3. K. Sohrawy, D. Minoli, and T. Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, 1<sup>st</sup> Edition, Wiley Inter Science, 2010..

#### Online Resources:

1. <https://nptel.ac.in/courses/106/105/106105160/>: by Prof. S. Misra, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain sensing, computing and communication tasks of wireless sensor networks.
CO2	Deploy wireless sensors and design communication protocols in WSNs.
CO3	Analyze localization and tracking issues in wireless sensor networks.
CO4	Explain the concepts of MAC layer protocols for WSNs.
CO5	Compare various WSN routing techniques and their implications.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1							1	3		1
CO2	3	3	2	3	3							1	3		1
CO3	3	3	3	3	3							1	3		1
CO4	3	3	2	2	2							1	3		1
CO5	3	3	3	3	2							1	2		1

Type	Code	Fiber Optic Communications	L-T-P	Credits	Marks
PE	18EC2T42		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study various modes, configurations and transmission characteristics of optical fibers including fiber fabrications, optoelectronic sources, photo detectors, optical modulators, optical amplifiers and various types of optical networks.
<b>Pre-Requisites</b>	Basic knowledge of physics, particularly ray optics, and electromagnetic wave propagation through waveguides is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Fundamentals of fiber optics, Different generations of optical fiber communication systems, Optical fiber structure, Fiber types, Step index fiber, Graded index fiber, Basic optical laws & definitions, Ray propagation, Total internal reflection, Numerical aperture, Acceptance angle, Wave propagation in planar waveguides, Wave propagation in a cylindrical waveguides, Modal concept, V-number, Power flow in step & graded index fibers.	<b>9 Hours</b>
<b>Module-2</b>	<b>Transmission Characteristics:</b> Attenuation (absorption, scattering and bending) and dispersion (inter and intramodal, chromatic, wave guide and polarization), Dispersion shifted and Dispersion flattened fibers; <b>Nonlinear Optical Effects:</b> Stimulated light scattering, Nonlinear phase modulation and four-wave mixing; <b>Optical Fiber Cables and Connections:</b> Fiber fabrication, Double crucible method, Fiber optic cables, Connector and splice, Losses during coupling between source to fiber, fiber to fiber; Schemes for coupling improvement.	<b>9 Hours</b>
<b>Module-3</b>	<b>Optical Sources &amp; Detectors:</b> Sources - Intrinsic and extrinsic materials - direct and indirect band gaps, LED: LED structures, Surface emitting and edge emitting LED, LED quantum efficiency, Modulation response of an LED, Injection LASER Diodes (ILDs) - Threshold conditions, LASER modes, Modulation response of ILDs, Optoelectronic Detectors - PIN AND APD, Responsivity, Band width, Detector noise equivalent circuit and SNR calculation.	<b>8 Hours</b>
<b>Module-4</b>	<b>Opto-electronic Modulators:</b> Basic principles, Electro-optic modulators - Electro-optic effect, Longitudinal modulator, Transverse modulator; Acousto-optic modulators - Raman-Nath modulator, Bragg modulator; <b>Optical Amplifiers:</b> Introduction, General applications of optical amplification, Semiconductor optical amplifier (SOA) - Characteristics, Limitations, Basic principles and Optical gain, Erbium-doped fiber amplifier (EDFA) - Characteristics, Operating principle and Optical gain.	<b>8 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>WDM Components &amp; Optical Switching:</b> WDM concept, Couplers, Isolators, Circulators, Filters, Optical Cross-connect (OXC), Optical Add/Drop Multiplexing (OADM); <b>Optical Networks:</b> Elements of optical Networks - SONET/SDH, Optical interfaces, SONET/SDH Rings, SONET/SDH Networks, Optical Ethernet.	8 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. G. Keiser, *Optical Fiber Communications*, 4<sup>th</sup> Edition, Tata McGraw-Hill, 2013.
- T2. J. M. Senior, *Optical Fiber Communication: Principles and practice*, 3<sup>rd</sup> Edition, Prentice Hall of India, 2009.

**Reference Books:**

- R1. G. P. Agarwal, *Fiber-Optic Communication Systems*, 4<sup>th</sup> Edition, John Wiley & Sons, 2011.
- R2. R. P. Khare, *Fiber Optics and Optoelectronics*, Oxford University Press, 2004.

**Online Resources:**

1. <https://nptel.ac.in/courses/108/104/108104113/>: by Dr. P. Kumar, IIT Kanpur
2. <https://nptel.ac.in/courses/117/101/117101002/>: by Prof. R. K. Shevgaonkar, IIT Bombay
3. <https://nptel.ac.in/courses/117104127/>: by Dr. P. Kumar, IIT Kanpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe fundamentals of fiber optics, its structure, types and wave propagation through fiber.
CO2	Estimate the losses and analyze the propagation characteristics of an optical signal in different types of fibers.
CO3	Describe and compare the basic principles and characteristics of different types of optical sources and detectors.
CO4	Analyze the performance of different types of optical modulators and amplifiers.
CO5	Summarize the applications of different WDM components, optoelectronic switching circuits and optical networks.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

*Cont'd...*



PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	1	1					2	2	1	1
CO2	3	3	3	2	3	2	2					2	3	1	2
CO3	3	3	3	2	3	2	1					2	3	1	2
CO4	3	2	3	1	2	1	1					3	3	1	2
CO5	3	3	3	2	3	2	2					2	3	2	1

Type	Code	Satellite Communication Systems	L-T-P	Credits	Marks
PE	18EC2T57		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study modern satellite based communication systems for designing different downlinks, uplinks, along with preparation of link budgets to avoid signal outage for effective communications via satellites.
<b>Pre-Requisites</b>	Basics of analog & digital communication, and microwaves are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Architecture:</b> Principles and architecture of satellite communication, Brief history, advantages, disadvantages, applications, and frequency bands used for satellite communication. <b>Orbital Analysis:</b> Orbital equations, Kepler's laws of planetary motion, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc., of a satellite, Locating satellites with respect to earth, Look angles determination.	<b>9 Hours</b>
<b>Module-2</b>	<b>Satellite Sub-systems:</b> Architecture and roles of various sub-systems of a satellite system such as telemetry, tracking, command, and monitoring (TTC & M), Altitude and orbit control system (AOCS), Communication sub-system, Power sub-systems, Antenna sub-system, Equipment reliability, and space qualifications.	<b>8 Hours</b>
<b>Module-3</b>	<b>Typical Phenomena in Satellite Communication:</b> Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift, Range variations and remedies, orbital perturbations.	<b>8 Hours</b>
<b>Module-4</b>	<b>Satellite Link Budget:</b> Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communication system (satellite telephony) using LEO.	<b>9 Hours</b>
<b>Module-5</b>	<b>Modulation and Multiple Accessing Techniques:</b> Analog FM transmission by satellite, Digital transmission, TDM, FDMA, TDMA, CDMA, Typical case studies of VSAT, DBS-TV satellites, GPS.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. T. Pratt, C. Bostian, and J. Allnutt, *Satellite Communications*, 2<sup>nd</sup> Edition, Wiley India, 2010.
- T2. W. L. Pritchard, H. G. Suyderhoud, and R. A. Nelson, *Satellite Communication Systems Engineering*, Pearson Education, 2003.

**Reference Books:**

- R1. T. T. Ha, *Digital Satellite Communications*, 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2009.
- R2. D. Roddy, *Satellite Communications*, 4<sup>th</sup> Edition, Tata McGraw-Hill, 2008.
- R3. A. K. Maini and V. Agrawal, *Satellite Communications*, Willey, 2019.

**Online Resources:**

1. <https://nptel.ac.in/courses/117/105/117105131/>: by Prof. K. Bandyopadhyay, IIT Kharagpur
2. <https://nptel.ac.in/courses/101/105/101105077/>: by Dr. M. Sinha, IIT Kharagpur
3. <https://nptel.ac.in/courses/105/107/105107194/>: by Prof. A. K. Saraf, IIT Roorkee

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the fundamentals and orbital mechanics of satellite communication systems.
CO2	Explain different satellite subsystems for effective communication.
CO3	Analyze and solve problems related to orbital effects of satellites.
CO4	Optimize practical satellite links considering various atmospheric propagation effects.
CO5	Analyze and optimize different modulation and MAC techniques in case studies.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2							1	2		1
CO2	3	3	3	2	3	1						1	3	1	1
CO3	3	3	3	2	3	1						1	3	1	1
CO4	3	3	3	2	3	2						1	3	1	1
CO5	3	3	3	2	2	2						1	3	1	1

Type	Code	Bio-Medical Electronics	L-T-P	Credits	Marks
PE	18EI2T31			3-0-0	3

<b>Objectives</b>	The objective of this course is to study different biomedical instruments, sensors, signal processing techniques, and their application in diagnosis, therapeutic and surgical procedures.
<b>Pre-Requisites</b>	Knowledge of basic electronics, sensors, and transducers are required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT, audio & video tools as required; sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours			
<b>Module-1</b>	<b>Introduction to Bio-Engineering:</b> Bio-medical signals - sources & examples, Basic medical instrumentation system, use of microprocessors, design constraints; Bio-electric potentials: Sources, Resting & action potentials; Biomedical Signals: Anatomy of heart, ECG, PCG, EEG, EMG.	<b>9 Hours</b>			
<b>Module-2</b>	<b>Biomedical Electrodes and Recorders:</b> Electrode theory, Recording electrodes, Bio-potential Electrodes for ECG, EEG and EMG, Microelectrodes, ECG recorder, Sources of artifacts in ECG and their removal methods, EEG & EMG recorder.	<b>8 Hours</b>			
<b>Module-3</b>	<b>Patient Care Monitoring:</b> System concepts, Measurement of heart rate, Measurement of pulse rate, Types of Blood pressure and blood flow measurement.	<b>8 Hours</b>			
<b>Module-4</b>	<b>X-Ray and Radioisotope Instrumentation:</b> Generation of Ionizing Radiation, Nature and production of X-Rays, Computed Tomography, Magnetic Resonance Imaging System, Ultrasonic Imaging Systems.	<b>8 Hours</b>			
<b>Module-5</b>	<b>Bio Sensors:</b> Basic Transducer Principles - The Transducer and Transduction Principles, Classification of Transducer, Transducers for Biomedical Applications, Glucose sensors, Immune Sensors, MOSFET biosensors & BIOMEMS and Smart sensors.	<b>9 Hours</b>			
<b>Total</b>					<b>42 Hours</b>

#### Text Books:

- T1. R. S. Khandpur, *Handbook of Biomedical Instrumentation*, 3<sup>rd</sup> Edition, McGraw Hill Education, 2014.
- T2. D. C. Reddy, *Biomedical Signal processing - Principles & Techniques*, 1<sup>st</sup> Edition, Tata McGraw Hill, 2005.
- T3. R. M. Rangayyan, *Biomedical Signal Analysis - A case Study Approach*, 2<sup>nd</sup> Edition, John Willey & Sons, 2002.

#### Reference Books:

- R1. J. L. Cromwell, F. J. Weibell, and E. A. Pfeiffer, *Biomedical Instrumentation and Measurement*, 2<sup>nd</sup> Edition, Prentice Hall of India, 2017.

- R2. J. J. Carr and J. M. Brown, *Introduction to Biomedical Equipment Technology*, 4<sup>th</sup> Edition, Pearson Education, 2000.
- R3. H. E. Thomas, *Handbook of Biomedical Instrumentation and Measurement*, Reston Publishing Company, 1974.

#### Online Resources:

1. <https://nptel.ac.in/courses/102101068/>: by Prof. S. Srivastava, IIT Bombay
2. <https://nptel.ac.in/courses/108/105/108105101/>: by Prof. S. Mukhopadhyaya, IIT Kharagpur
3. <https://nptel.ac.in/courses/108/105/108105091/>: by Prof. D. Sheet, IIT Kharagpur
4. <https://ocw.mit.edu/courses/biological-engineering/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the operating principles, design and applications of biomedical engineering.
CO2	Describe human physiological system with respect to design consideration of medical equipment.
CO3	Compare different medical recording and imaging systems and explain the limitations of pathological diagnosis.
CO4	Realize the risk factors of different medical instruments and electrical safety parameters.
CO5	Determine application of bio-sensors for biomedical signal processing in specific applications.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1			1	3					2	1	
CO2	1	1	2	3	1			2					2	1	
CO3	2	2	1	2		1	2	2					1		
CO4	2	1	2	2		1		3					2		
CO5	3	2	2	1		1	2	1					1		

Type	Code	Renewable Energy Systems	L-T-P	Credits	Marks
OE	18EE3T40			3-0-0	3

<b>Objectives</b>	The objective of this course is to study various types of renewable energy sources, the technologies for generation, storage, and proper utilization of renewable energy.
<b>Pre-Requisites</b>	Basic knowledge on semiconductor physics, fluid dynamics and electrical machines is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as needed, sessions are planned to be interactive with focus on real world examples and case-studies.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction: Conventional & non-conventional energy sources, their impact, availability, variability, Indian and world scenario; Solar, Wind, Biomass, Wave, Tidal, Geothermal energy systems; Solar Energy: Solar processes, Composition of solar radiation; Extra-terrestrial & terrestrial radiation, Angles - Azimuth, Zenith, Hour; Irradiance, Solar constant; Solar Thermal Systems & Applications: Solar collectors, Types & performance characteristics, Water heating systems (active & passive), Space heating & cooling systems, Desalination systems, Solar cooker, Solar thermal power plant.	<b>8 Hours</b>
<b>Module-2</b>	Solar Photovoltaic System: Operating principle, Photovoltaic cell concepts, Cell, Module, Array, Losses in solar cell, Effects of partial & complete shadowing, Series and parallel connections, Cell mismatching, PV voltage-current characteristics, Equivalent circuit, Maximum power point tracking; Applications: battery charging, Pumping, Lighting, Peltier cooling.	<b>10 Hours</b>
<b>Module-3</b>	Biomass Power: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Types of biogas digester, Wood gasifier, Pyrolysis, Applications, Biogas, Wood stoves, Bio diesel, Combustion engine, Urban waste to energy conversion, Biomass based power generation.	<b>9 Hours</b>
<b>Module-4</b>	Wind Energy: Wind energy, Variability, Conversion principle; Wind power density, Efficiency limit, Types of converters, Aerodynamics of rotors, Power~Speed and Torque~Speed characteristics, Wind turbine control systems; Conversion to Electrical Power: Induction and synchronous generators, Grid connected & self excited induction generator operation, Constant voltage & constant frequency generation with power electronic control, Single & double output systems, Reactive power compensation, Characteristics of wind power plant, Concepts of DFIG.	<b>10 Hours</b>

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Module-#	Topics	Hours
Module-5	Energy Storage Systems: Batteries, Ultra capacitors, SMES; Fuel Cell: Fuel Cell Basics, History of fuel cell technology, Open circuit voltage, Nernst equation analysis, Causes for voltage loss, Types of fuel cell and their efficiency, Applications; Introduction to Hybrid Energy Systems: PV-Wind, PV-Fuel Cell, PV-Diesel.	5 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. G. Boyel, *Renewable Energy - Power for a Sustainable Future*, 3<sup>rd</sup> Edition, Oxford University Press, 2012.
- T2. B. H. Khan, *Non-Conventional Energy Resources*, 3<sup>rd</sup> Edition, McGraw Hill Education, 2017.
- T3. S. N. Bhadr, D. Kastha, and S. Banerjee, *Wind Electrical Systems*, 7<sup>th</sup> Edition, Oxford University Press, 2005.

**Reference Books:**

- R1. S. A. Abbasi and N. Abbasi, *Renewable Energy Sources and Their Environmental Impact*, 1<sup>st</sup> Edition, PHI Learning, 2004.
- R2. S. H. Saeed and D. K. Sharma, *Non-Conventional Energy Resources*, 4<sup>th</sup> Edition, S. K. Kataria & Sons, 2019.
- R3. S. Peake, *Renewable Energy : Power for a Sustainable Future*, 4<sup>th</sup> Edition, Oxford University Press, 2018.

**Online Resources:**

1. <https://nptel.ac.in/courses/103/107/103107157/>: by Prof. B. Mondal, IIT Roorkee
2. <https://nptel.ac.in/courses/108/105/108105058/>: by Prof. S. Banerjee, IIT Kharagpur
3. <https://nptel.ac.in/courses/121/106/121106014/>: by Dr. P. Haridoss, IIT Madras

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Generalize solar thermal systems and identify various alternate energy sources & their characteristics.
CO2	Analyse and design a solar photovoltaic system for specified applications.
CO3	Evaluate the effectiveness of biomass energy conversion in waste management.
CO4	Design wind energy systems and analyze their operational characteristics.
CO5	Investigate the operation of fuel cell and configuration of different hybrid energy systems.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	2	2					1	3	1	1
CO2	3	1	2	2	2	1	2					1	2	3	2
CO3	1	1	2	1	1	2	3					1	2	1	1
CO4	3	1	2	2	2	1	3					1	3	2	2
CO5	1	1	2	2	1	1	2					1	2	1	1

Type	Code	Stochastic Processes	L-T-P	Credits	Marks
OE	18BS3T12		3-0-0	3	100

<b>Objectives</b>	The objectives of this course is to gain mathematical maturity by equipping the students to handle computing probability in different conditions and studying the concepts of Markov chain & Queuing theory.
<b>Pre-Requisites</b>	Knowledge of Sets, Probability, and Linear Algebra is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Review of basics of Probability - Probability of an event, Conditional probability, Independent event and Bayes' formula, Random variables, Discrete and Continuous, Distribution functions, Joint distribution & independent random variables, Expectation, Variance and covariance, Variance of a sum, Conditional distribution & conditional expectation (discrete case), Conditional distribution & conditional expectation (continuous case), Computing expectation & variance by conditioning, Computing probabilities by conditioning.	<b>8 Hours</b>
<b>Module-2</b>	Stochastic Processes, Markov Chain - Introduction and definition, Chapman-Kolmogorov equations, Classification of states, Limiting probabilities, Some application problems, Mean time spent in transient state, Branching processes, Time reversible Markov chains.	<b>11 Hours</b>
<b>Module-3</b>	Markov decision process, Hidden Markov chain, Exponential distribution and its properties, Counting process & definition of Poisson process, Inter arrival & waiting time distribution, Further properties of Poisson process, Non-homogeneous Poisson process.	<b>8 Hours</b>
<b>Module-4</b>	Continuous-time Markov chain, Birth & death process, The transition probability function, Limiting probabilities, Time reversibility, Computing the transition probabilities.	<b>7 Hours</b>
<b>Module-5</b>	Terms & notations in Queuing Theory, Steady state probabilities, A single server exponential queuing system (M/M/1), M/M/1 system with finite capacity, An application problem, The system M/G/1, Multiserver queues.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

T1. S. M. Ross, *Introduction to Probability Models*, 10<sup>th</sup> Edition, Academic Press, 2009.

#### Reference Books:

R1. J. Medhi, *Stochastic Processes*, 4<sup>th</sup> Edition, New Age International, 2019.

**Online Resources:**

1. <https://nptel.ac.in/courses/110/101/110101141/>: by Prof. M. Hanawal, IIT Bombay
2. <https://nptel.ac.in/courses/111/102/111102111/>: by Dr. S. Dharmaraja, IIT Delhi
3. <https://nptel.ac.in/courses/115/106/115106089/>: by Prof. V. Balakrishnan, IIT Madras
4. <https://nptel.ac.in/courses/111/102/111102098/>: by Dr. S. Dharmaraja, IIT Delhi

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Apply probability models to real life engineering problems.
CO2	Explain Markov chain and classification of states.
CO3	Solve problems using the concepts of hidden Markov chain and Poisson process.
CO4	Apply Markov chain in problems of different field of engineering.
CO5	Apply Queuing theory in engineering and daily life situations.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1								2	1	1
CO2	3	3	2	2	2								2	1	1
CO3	3	2	2	2	2								2	1	1
CO4	3	3	2	2	3								2	1	1
CO5	3	3	3	3	3								2	1	1

Type	Code	Project Management	L-T-P	Credits	Marks
OE	18BS3T13		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study the fundamental tools and behavioral skills necessary to successfully launch, lead, and realize benefits, develop the skills for planning and controlling, and understanding key factors to drive successful project outcomes.
<b>Pre-Requisites</b>	General knowledge of any organization and its operations is sufficient.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with real-life examples.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Project Systems Management: a life cycle approach, project characteristics; Project life cycle phases - conception, definition, planning and organizing, implementation, clean up; Project feasibility analysis - market, technical, financial; The project manager: roles & responsibilities, team building and conflict management; Tools and techniques for project management; Environmental impact analysis of a project.	<b>9 Hours</b>
<b>Module-2</b>	Commonly used techniques for Project Management, Network techniques - PERT, CPM and GERT; Project appraisal criteria - NPV, IRR; Pay back period, sensitivity analysis; Line of Balance (LOB), Accounting for risk, uncertainty and fuzziness. Time cost trade-offs and crashing procedures; Multi project planning & scheduling with limited resources; Multi objective, fuzzy and stochastic based formulations in a project environment.	<b>9 Hours</b>
<b>Module-3</b>	Project Resource Management: Allocation, Leveling and Smoothing methods; Multi project and multi resource, multi-mode scheduling under various constraints - limited resources, limited budget, non-split, start/end lag; Application of Heuristics.	<b>8 Hours</b>
<b>Module-4</b>	Cost Benefit Analysis: Cost benefit analysis – projects procurement process, life cycle costing, project cost reduction methods, project stores; Project Cost: Dynamics of project cost, Estimation of capital cost, Estimating operating costs, Forecasting income, Financial sources, Role of development financial institutions; Social cost benefit analysis.	<b>8 Hours</b>
<b>Module-5</b>	Planning, Monitoring and Control: Design of monitoring system, Computerized PMIS (Project Management Information System); Funds planning, performance budgeting and control; Project materials management; Pricing, estimating, and Contract Administration & Management, Building & Bid evaluation and analysis.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

T1. R. Paneerselvam and P. Senthilkumar, *Project Management*, 1<sup>st</sup> Edition, PHI Learning, 2009.

T2. B. Punmia and K. Khandelwal, *Project Planning and Control with PERT and CPM*, 4<sup>th</sup> Edition, Laxmi Publications, 2006.

#### Reference Books:

- R1. P. Chandra, *Projects Planning, Analysis, Selection, Financing, Implementation and Review*, 9<sup>th</sup> Edition, McGraw Hill Education, 2019.
- R2. C. Gray, E. Larson, and G. Desai, *Project Management The Managerial Process*, 7<sup>th</sup> Edition, McGraw Hill, 2013.

#### Online Resources:

1. <https://nptel.ac.in/courses/110/104/110104073/>: by Prof. R. Sengupta, IIT Kanpur
2. <https://nptel.ac.in/courses/110/107/110107081/>: by Prof. S. K. Gupta & Prof. M. K. Barua, IIT Roorkee

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the fundamental project management tools and behavioral skills.
CO2	Explain the basic concept of various network techniques for project management.
CO3	Optimally utilize the resources for successful completion of a project.
CO4	Preform cost-benefit analysis of a project considering various factors involved.
CO5	Plan, monitor, control, and administer projects using computerized PMIS tools.

#### Program Outcomes Relevant to the Course:

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		1	2			1	1	1			3	1	1		1
CO2	1	1			2	1					3	1	1	1	1
CO3	1	2	2		3	1					3		1	1	1
CO4	1	2	2		2						3	1	1	2	1
CO5	2	2	1		1						3	1	1	1	1

Type	Code	Internet Technology & Applications	L-T-P	Credits	Marks
OE	18CS3T15		3-0-0	3	100

<b>Objectives</b>	The objective of the course is to study the technologies behind the Internet including protocols, client-side & server-side programming, and other advanced tools used to develop & deploy professional web applications.
<b>Pre-Requisites</b>	Knowledge of java, networking, and idea on Internet is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on programming activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction to Internet and WWW, Client-Server model, Browsers, IP Addresses, URLs and MIME; Internet Protocols, HTTP Request/Response model; Structure of a Web page, HTML and W3C, Elements, Attributes and Tags; Basic HTML Tags, Text and Lists, Links and Tables, Images and Colors, Forms, Interactive and Multimedia Tags in HTML. Document Type Definition.	<b>10 Hours</b>
<b>Module-2</b>	Cascading Style Sheets: Introduction, Advantages, Adding CSS, Browser compatibility, Page layout, Selectors. CSS Background, CSS Border, CSS Box Model, CSS Display and Float, CSS Tables, CSS Pseudo class and elements; CSS3: Additional features (Box, Shadow and Effects).	<b>9 Hours</b>
<b>Module-3</b>	JavaScript: Introduction, Variables, Literals, Operators, Conditional Statements, Arrays, Functions, Objects (Built-in and User-defined); JavaScript and HTML DOM: Window, Location, Navigator objects, Events and Event Handlers, Navigating the DOM tree, Creating, Adding, Inserting, Removing and Replacing nodes, Document Object properties; Accessing and Validating the Form fields.	<b>9 Hours</b>
<b>Module-4</b>	XML: Use, Declaration, Elements, Attributes, Validation, Display; XML DTD: XML Schema, Validation, Using DTD in an XML Document; XML DOM and XML Transformation; AJAX: Use and benefits, Asynchronous communication, Processing steps, Sending and Retrieving information; JSP: Introduction and life cycle, JSP Service Methods, Elements in a JSP Page, JSP Objects, JSP Tags, JSP Exceptions, JSP Example.	<b>9 Hours</b>
<b>Module-5</b>	Web Services: Evolution, Purpose and Standards, Programming Models, WSDL, SOAP based web services, REST based web services; E-Commerce and Security, Digital Signature and Authentication.	<b>5 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. M. Srinivasan, *Web Technology: Theory and Practice*, 2<sup>nd</sup> Edition, Pearson Education, 2012.  
 T2. U. K. Roy, *Web Technologies*, 1<sup>st</sup> Edition, Oxford University Press, 2016.

**Reference Books:**

- R1. T. A. Powell, *HTML & CSS: The Complete Reference*, 5<sup>th</sup> Edition, McGraw-Hill Education, 2017.
- R2. B. A. Forouzan, *Data Communication and Networks*, 4<sup>th</sup> Edition, McGraw-Hill Education, 2017.
- R3. T. A. Powell and F. Schneider, *JavaScript 2.0 - The Complete Reference*, 4<sup>th</sup> Edition, McGraw-Hill Education, 2017.

**Online Resources:**

1. <https://nptel.ac.in/courses/106/105/106105084/>: by Prof. I. Sengupta, IIT Kharagpur
2. <https://www.w3schools.com/html/default.asp>
3. <https://www.w3schools.com/css/default.asp>
4. <https://www.tutorialspoint.com/javascript/index.htm>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the basics of Internet Technology and the structure of the world wide web.
CO2	Design professional web pages using HTML and CSS.
CO3	Create interactive web pages using Java script and XML.
CO4	Use server side programming to create dynamic web applications.
CO5	Explore & make use of web services and investigate security issues in Internet.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	1							2	2	1	3
CO2	3	2	2	1	2							2	1	1	2
CO3	3	3	2	2	3							2	1	1	2
CO4	2	3	2	2								2	1	1	2
CO5	2	2	2	3									1	1	3



Type	Code	Introduction to Machine Learning	L-T-P	Credits	Marks
OE	18CS3T16		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study various supervised, unsupervised, and reinforcement learning techniques & algorithms to discover patterns in data and make predictions based on the patterns for solving business problems.
<b>Pre-Requisites</b>	Knowledge of engineering mathematics is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Overview of supervised learning, K-nearest neighbour, Multiple linear regression, Shrinkage methods (Ridge regression, Lasso regression), Subset selection, Linear Discriminant Analysis, Logistic regression.	<b>9 Hours</b>
<b>Module-2</b>	Bias, Variance, and model complexity, Cross-validation, Bootstrap methods, Regression and classification trees, Boosting methods, AdaBoost and Random forest.	<b>8 Hours</b>
<b>Module-3</b>	Generative model for discrete data (Bayesian concept learning, Naïve Bayes classifier), SVM for classification, Reproducing Kernels, SVM for regression.	<b>8 Hours</b>
<b>Module-4</b>	Clustering (K-means, spectral clustering), Feature Extraction (Principal Component Analysis (PCA), kernel based PCA, Independent Component Analysis (ICA), Non-negative matrix factorization).	<b>9 Hours</b>
<b>Module-5</b>	Introduction to Reinforcement learning, Single State Case: K-Armed Bandit, Elements of Reinforcement Learning, Model-Based Learning (Value Iteration, Policy Iteration).	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning - Data Mining, Inference, and Prediction*, 2<sup>nd</sup> Edition, Second Edition, 2009.
- T2. S. Haykin, *Neural Networks and Learning Machines*, 3<sup>rd</sup> Edition, Pearson Education, 2009.
- T3. E. Alpaydm, *Introduction to Machine Learning*, 2<sup>nd</sup> Edition, Prentice Hall of India, 2010.

#### Reference Books:

- R1. Y. G. James, D. Witten, T. Hastie, and R. Tibshirani, *An Introduction to Statistical Learning with Applications in R*, 2<sup>nd</sup> Edition, Springer, 2013.
- R2. T. M. Mitchell, *Machine Learning*, 1<sup>st</sup> Edition, McGraw-Hill Education, 2013.
- R3. C. M. Bishop, *Pattern Recognition and Machine Learning*, 1<sup>st</sup> Edition, Springer, 2006.

#### Online Resources:

1. <https://nptel.ac.in/courses/106/106/106106139/>: by Dr. B. Ravindran, IIT Madras
2. <https://nptel.ac.in/courses/106/105/106105152/>: by Prof. S. Sarkar, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Apply supervised machine learning models to solve related real life problems.
CO2	Analyze and select the best suitable supervised models among many.
CO3	Apply classification and regression models such as SVM and decision tree based models.
CO4	Extract important features from the given data set and apply clustering techniques.
CO5	Apply reinforcement learning models to solve related real life problems.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	1							1	3	1	2
CO2	3	2	3	1	1							1	3	1	3
CO3	3	3	3	2	1							1	3	1	2
CO4	3	2	2	2	1							1	3	1	2
CO5	2	3	2	2	1							1	3	1	3

Type	Code	Biomedical Instrumentation & Signal Processing	L-T-P	Credits	Marks
OE	18EI3T05		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study various biomedical instruments, sensors and signal processing techniques, and their applications in diagnosis, therapeutic and surgical procedures.
<b>Pre-Requisites</b>	Knowledge of basic electronics, sensors, and transducers is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on real-world applications.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction to Bioengineering:</b> Sources and examples of biomedical signals, Basic medical Instrumentation system, use of microprocessors, general design constraints; <b>Transducers:</b> Classification, Transducers for Biomedical Applications; <b>Sources of Bio-electric Potentials:</b> Resting and Action Potentials; <b>Anatomy of heart,</b> Different types of Biomedical Signals: ECG, PCG, EEG, EMG.	<b>9 Hours</b>
<b>Module-2</b>	<b>Biomedical Electrodes and Recorders:</b> Electrode theory, Recording electrodes, Bio-potential Electrodes for ECG, EEG and EMG, Microelectrodes, ECG recorder, Sources of Artifacts in ECG and their removal methods, EEG & EMG recorder.	<b>8 Hours</b>
<b>Module-3</b>	<b>Patient Care Monitoring:</b> System concepts, Measurement of heart rate, Measurement of pulse rate, Blood pressure and blood flow measurement, Pacemakers and Defibrillators, Electric shock hazards, Leakage currents.	<b>8 Hours</b>
<b>Module-4</b>	<b>X-Ray and Radioisotope Instrumentation:</b> Generation of Ionizing Radiation, Nature and production of X-Rays, Computed Tomography, Magnetic Resonance Imaging System, Ultrasonic Imaging Systems.	<b>8 Hours</b>
<b>Module-5</b>	<b>Adaptive Filters:</b> Principle, the steepest descent algorithm, adaptive noise canceller, cancellation of interference in electrocardiography, applications; Canceling Donor heart Adaptive filters, HF noise in ECG, motion artifact in ECG, maternal interference in Fetal ECG, cancellation of maternal ECG, cancellation of ECG signal from electrical activity of chest muscles, cancellation of HF noise in Electro-surgery.	<b>9 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. R. S. Khandpur, *Handbook of Biomedical Instrumentation*, 2<sup>nd</sup> Edition, McGraw-Hill, 2002.
- T2. D. C. Reddy, *Biomedical Signal processing - Principles & Techniques*, 1<sup>st</sup> Edition, McGraw-Hill, 2005.
- T3. R. M. Rangayyan, *Biomedical Signal Analysis - A Case Study Approach*, 2<sup>nd</sup> Edition, John Wiley & Sons, 2002.

**Reference Books:**

- R1. J. L. Cromwell, F. J. Weibell, and E. A. Pfeiffer, *Biomedical Instrumentation and Measurement*, 2<sup>nd</sup> Edition, Prentice Hall of India, 2017.
- R2. J. J. Carr and J. M. Brown, *Introduction to Biomedical Equipment Technology*, 4<sup>th</sup> Edition, Pearson Education, 2000.
- R3. H. E. Thomas, *Handbook of Biomedical Instrumentation and Measurement*, 1<sup>st</sup> Edition, Reston Publishing Company, 1974.

**Online Resources:**

1. <https://nptel.ac.in/courses/102101068/>: by Prof. S. Srivastava, IIT Bombay
2. <https://nptel.ac.in/courses/108105101/>: by Prof. S. Mukhopadhyay, IIT Kharagpur
3. <https://ocw.mit.edu/courses/biological-engineering/20-010j-introduction-tobioengineering-be-010j-spring-2006/videos/>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the principles and design of biomedical instruments and applications of biomedical engineering.
CO2	Explain design considerations for medical equipment with respect to the human physiological system.
CO3	Describe the principle of operation of various medical recording and imaging systems.
CO4	Identify the elements of risk for different instrumentation methods and basic electrical safety.
CO5	Explain different adaptive methods for biomedical signal processing and noise cancellation.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
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**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1			1	3			1		2		
CO2	1	1	2	3	1			2					2		
CO3	2	2	1	2		1	2	2					2	1	
CO4	2	1	2	2		1		3					1		
CO5	3	2	1	2		2		1					1	1	

Type	Code	Virtual Instrumentation	L-T-P	Credits	Marks
OE	18EI3T17			3-0-0	3

<b>Objectives</b>	The objective of this course is to study fundamentals, programming techniques, data acquisition systems, communication buses, and various other aspects to design & develop virtual instrumentation systems for different applications.
<b>Pre-Requisites</b>	Knowledge of sensors, transducers, actuators, analog & digital electronics, and computer programming is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on design & programming activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Historical perspectives, advantages, block diagram & architecture of a virtual instrument, Conventional instruments vs. Traditional instruments, Data-flow techniques, Graphical programming in data flow, Comparison with conventional programming.	<b>7 Hours</b>
<b>Module-2</b>	<b>VI Programming:</b> FOR and WHILE Loops, Additional loop problem, Loop behaviour & inter-loop communication, Local & Global variables, Shift registers, Feedback, Auto-indexing, Loop timing, Timed loop; Other Structures: Sequence structures, Case structures, Formula node, Event structure; Arrays & Clusters: Arrays, Clusters, Inter-conversion of arrays & clusters; Graphs & Charts: Waveform chart, Resetting plots, Waveform graph, Use of cursors, X-Y graph; File Input/Output: File formats, File I/O functions, Path functions, Examples of file READ/WRITE; String Handling: String functions, LabVIEW string formats, Parsing of strings.	<b>10 Hours</b>
<b>Module-3</b>	<b>Data Acquisition:</b> Introduction, Sampling fundamentals, I/O techniques and buses, ADCs, DACs, Digital I/O, Counters and timers, DMA, Software & hardware installation, Calibration, Resolution, Data acquisition interfaces: Requirements, Issues involved in selection of data acquisition cards, Cards with serial communication, VI chassis requirements; PC Buses: Local busses - ISA, PCI, RS232, RS422, RS485; Interface Buses: USB, PCMCIA, VXI, SCXI, PXI; Instrumentation Buses: Modbus & GPIB, Networked buses, ISO/OSI reference model, Ethernet & TCP/IP Protocols.	<b>10 Hours</b>
<b>Module-4</b>	<b>VI Toolsets:</b> Use of analysis tools, Fourier transforms, Power spectrum, Correlation methods, Windowing and filtering; Application of VI in designing of process control equipment like Oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual laboratory, Web based laboratory.	<b>7 Hours</b>

Cont'd...

Module-#	Topics	Hours
Module-5	<b>Applications:</b> Distributed I/O modules, Instrument control, Development of process database management system, Simulation of systems using VI, Development of control system, Industrial communication, Image acquisition and processing, Motion control, Development of Virtual Instruments using GUI, Real-time systems, Embedded controller, OPC, HMI/SCADA software, Active-X programming.	8 Hours
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. G. Johnson, *LabVIEW Graphical Programming*, 4<sup>th</sup> Edition, McGraw Hill, 2006.  
 T2. J. Travis and J. Kring, *LabVIEW for Everyone: Programming Made Easy and Fun*, 3<sup>rd</sup> Edition, Prentice Hall, 2006.

**Reference Books:**

- R1. K. James, *PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control*, 1<sup>st</sup> Edition, Newnes, 2000.  
 R2. G. W. Johnson and R. Jeninngs, *LabVIEW Graphical Programming*, 4<sup>th</sup> Edition, McGraw-Hill Education, 2019.  
 R3. P. A. Blume, *The LabVIEW Style Book*, 1<sup>st</sup> Edition, Prentice Hall, 2017.

**Online Resources:**

- <http://www.nitttrchd.ac.in/sitenew1/nctel/electrical.php>
- <http://iota.ee.tuiasi.ro/~master/Signals%20&%20DAQ.pdf>
- [http://www.setsunan.ac.jp/~shikama/LabVIEW\\_Elvis\\_Multisim/060803\\_Introduction\\_to\\_LabVIEW\\_8\\_in\\_6\\_Hours.pdf](http://www.setsunan.ac.jp/~shikama/LabVIEW_Elvis_Multisim/060803_Introduction_to_LabVIEW_8_in_6_Hours.pdf)
- <http://www.ece.mtu.edu/labs/EElabs/EE3010/Lecture%20Notes/Chapter%2009.pdf>
- [http://ece-research.unm.edu/jimp/415/labview/LV\\_Intro\\_Six\\_Hours.pdf](http://ece-research.unm.edu/jimp/415/labview/LV_Intro_Six_Hours.pdf)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the fundamentals of Virtual Instrumentation developments and design.
CO2	Apply programming skills for Virtual Instrumentation system design.
CO3	Correlate data acquisition & communication for design of indigenous virtual instruments.
CO4	Demonstrate the use of virtual instrumentation tool sets.
CO5	Design and develop virtual instrumentation systems for specific industrial applications.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

*Cont'd...*

PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	2	1							2		
CO2	2	2	3		2							1	2		1
CO3	3	1	2	1	2							1	2		1
CO4	1	1	2	1	2								1		
CO5	2	3	2	2	1	2						2	2		2



Type	Code	Energy Studies	L-T-P	Credits	Marks
OE	18EE3T33		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to study energy systems with emphasis on technologies & initiatives for renewable & alternative energy sources.
<b>Pre-Requisites</b>	General knowledge on physics, electricity, and environment is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on examples and case studies.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Sources of Energy:</b> Conventional & non-conventional sources of energy, Fossil fuels, Nuclear fuels, hydel, solar, wind and bio fuels in India, Energy conservation, Nuclear energy through fission and fusion processes.	<b>8 Hours</b>
<b>Module-2</b>	<b>Energy Conversion:</b> Energy conversion routes, Direct and indirect ways of energy conversion, Basic conversion techniques for Solar, Nuclear, Geothermal, Tide and Wind Energies.	<b>8 Hours</b>
<b>Module-3</b>	<b>Energy &amp; Environment:</b> Energy efficiency & conservation, Clean energy technologies, Importance in sustainable development, Greenhouse effect, Carbon footprint, Energy consumption & sustainability, Economics of energy, Economics of production versus consumption, Linkages between economic & environmental outcomes, Influence of economic, environmental, trade, and research policies on future energy.	<b>8 Hours</b>
<b>Module-4</b>	<b>Global &amp; Indian Energy Scenario:</b> Role of energy in economic development & social transformation, Overall energy demand, Availability & consumption, Depletion of energy resources & its impact on economy, Nonproliferation of nuclear energy; International energy policies of G-8, G-20, OPEC and European union countries, Kyoto protocol, Paris convention & other initiatives; Indian Energy Scenario: Commercial & non-commercial forms of energy, Utilization pattern in the past & present, Future prediction, Sector-wise energy consumption, Indian Energy Policy & regulation, Energy policy issues at global level, National level and state level, Energy Conservation Act 2001, Restructuring of Indian power sector & Electricity Act 2003, Energy pricing & its impact on global variations, National solar mission.	<b>10 Hours</b>
<b>Module-5</b>	<b>Energy Conservation:</b> Fundamentals of energy conservation, Energy management in power plant, Energy conservation in buildings, Heating, Ventilation, Evaluation of heat loss, Heat gain in building systems & air-conditioning system, Degree day in energy use monitoring, Energy conservation opportunities in chemical industries, Waste heat recovery, Co-generation, Energy conservation in agricultural sector, Energy conservation in illumination engineering.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. G. Boyel, *Renewable Energy - Power for a Sustainable Future*, 3<sup>rd</sup> Edition, Oxford University Press, 2012.
- T2. R. A. Ristinen and J. P. Kraushaar, *Energy and the Environment*, 2<sup>nd</sup> Edition, John Wiley & Sons, 2006.
- T3. F. Kreith and D. Y. Goswami, *Energy Management and Conservation Handbook*, 1<sup>st</sup> Edition, CRC Press, 2017.

**Reference Books:**

- R1. S. A. Abbasi and N. Abbasi, *Renewable Energy Sources and Their Environmental Impact*, Pentice Hall of India, 2004.
- R2. D. R. Jalilvand and K. Westph, *The Political and Economic Challenges of Energy in the Middle East and North Africa*, 1<sup>st</sup> Edition, Routledge (Taylor & Francis Group), 2017.
- R3. J. Goldemberg, *World Energy Assessment: Energy and the Challenge of Sustainability*, United Nations, 2001.
- R4. B. H. Khan, *Non-Conventional Energy Resources*, 3<sup>rd</sup> Edition, Tata McGraw-Hill, 2017.

**Online Resources:**

1. [https://en.wikipedia.org/wiki/Kyoto\\_Protocol](https://en.wikipedia.org/wiki/Kyoto_Protocol)
2. [https://en.wikipedia.org/wiki/Paris\\_Agreement](https://en.wikipedia.org/wiki/Paris_Agreement)

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Identify various alternate energy sources and their characteristics.
CO2	Analyze different energy conversion techniques for renewable energy systems.
CO3	Evaluate the effect of energy consumption on environment, economy and development.
CO4	Visualize global & national energy scenario and international energy policies.
CO5	Investigate different energy conservation techniques and energy management systems.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1				1	2					1	1	2	1
CO2	1	1				1	2					1	1	2	1
CO3						2	3	1				1		2	1
CO4						2	3	1				1		2	1
CO5	1	2				3	3	2				1	1	2	2

Type	Code	Simulation & Modelling	L-T-P	Credits	Marks
OE	18BS3T18		3-0-0	3	100

<b>Objectives</b>	The objective of this course is to learn the basic concepts and steps of statistical simulation along with some modeling problems for engineering, scientific, business, and social science processes in the real life.
<b>Pre-Requisites</b>	Basic knowledge of probability and statistics is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Basic concepts of Queue, M/M/1 and M/M/s queues, Queues involving non exponential distributions, Inventory models, Deterministic Continuous review model, Deterministic Periodic review model.	<b>8 Hours</b>
<b>Module-2</b>	Random number generation and its application to integration, Estimation of $\pi$ and other problems, Generating discrete random variable: Inverse Transform Method, Generating geometric random variable and Bernoulli Random variable, Generating Poisson and Binomial random variable, The Acceptance Rejection method, The composition Approach, Programming for Generation of discrete random variable.	<b>9 Hours</b>
<b>Module-3</b>	Generation of Continuous random variable: The inverse transform method, The rejection Method, Generating Normal random variable by different methods, Generating Poisson Process, Simulating a single server queuing system, A queuing system with two servers in series, A queuing system with two servers in parallel, An inventory Model, An Insurance Risk model.	<b>10 Hours</b>
<b>Module-4</b>	Simulation of A Repair model, Programming for simulation model, Reduction of Variance using Antithetic variables, Estimation of system reliability using antithetic variables, Application Problems, Reduction of variance using Control Variates, Application Problems, Variance by conditioning, Application Problems.	<b>8 Hours</b>
<b>Module-5</b>	Stratified Sampling, Reduction of variance using stratified sampling, Goodness of Fit for Discrete Data, Kolmogorov-Smirnov Test for Continuous Data, Goodness of Fit test when some parameters are unspecified, Two sample problem.	<b>7 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research*, 8<sup>th</sup> Edition, McGraw-Hill, 2005.
- T2. S. M. Ross, *Simulation*, 5<sup>th</sup> Edition, Academic Press, 2012.

**Reference Books:**

- R1. A. M. Law and W. D. Kelton, *Simulation Modeling and Analysis*, 4<sup>th</sup> Edition, McGraw-Hill Higher Education, 2005, Online: <https://fac.ksu.edu.sa/sites/default/files/index.pdf>.  
 R2. H. A. Taha, *Operations Research*, 8<sup>th</sup> Edition, Pearson Education, 2006.

**Online Resources:**

1. <https://nptel.ac.in/courses/110106062/>: by Prof. G. Srinivasan, IIT Madras
2. <https://nptel.ac.in/courses/111/107/111107128/>: by Prof. Kusumdeep, IIT Roorkee
3. <https://nptel.ac.in/courses/112/106/112106134/>: by Prof. G. Srinivasan, IIT Madras

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Understand the queue and inventory model and solve related problems.
CO2	Create discrete random variable.
CO3	Generate continuous random variable and simulate queues and inventory models.
CO4	Understand and apply the variance reduction methods in simulation.
CO5	Test the goodness of a simulation by analyzing the simulated data.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1								2	1	1
CO2	3	3	3	1	2								2	1	1
CO3	3	3	3	1	2								2	1	1
CO4	3	3	3	1	3								2	1	1
CO5	3	3	3	1	2								2	1	1

Type	Code	Entrepreneurship Development	L-T-P	Credits	Marks
OE	18BS3T20			3-0-0	3

<b>Objectives</b>	The objective of this course is to learn various aspects of becoming an entrepreneur by starting own business and making it successful so as to adopt entrepreneurship as a career option for graduating engineers.
<b>Pre-Requisites</b>	General knowledge of any business and its operations is sufficient.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with real-life examples & case studies.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Concept and Overview: Concept of Entrepreneurship, The Entrepreneurial Process, Entrepreneurial Motivation, Developing Entrepreneurial Competencies, Characteristics of successful entrepreneur, Role of Entrepreneurship in Economic Development, Evolution and Growth of entrepreneurship in India.	<b>8 Hours</b>
<b>Module-2</b>	Ideas, Creativity, Innovation, Markets and Entrepreneurship: Ideas to Reality, Creativity, Innovation and Entrepreneurship, Identifying and recognizing Opportunities, Techniques for generating Ideas, Encouraging and Protecting the new ideas and selecting the right project, Ensuring your market, Market survey and Research.	<b>8 Hours</b>
<b>Module-3</b>	Business Plan: Meaning, Contents and significance of business plan, Formulation of business plan, Presentation of business plan to the investors, Techno-economic feasibility Assessment: A preliminary Project Report, The Detailed Project Report, Project Appraisal, Methods of Project Appraisal	<b>9 Hours</b>
<b>Module-4</b>	Financial Plan, and Marketing and Human Resource Management: Creating a successful financial plan, Source of financing, Institutional Finance to entrepreneurs, Basic financial statements, Ratio Analysis, Break-even Analysis. Problems of HRM and Relevant Labour laws, Marketing Management of Enterprises, Institutional support to entrepreneurs in Marketing.	<b>9 Hours</b>
<b>Module-5</b>	Intellectual Property: Concept and importance of Intellectual Property, Patents, Trade Mark, Copy rights, Trade secrets, Intellectual property audit, Start up: The Concept, Start up Policy of Government of India and Odisha in MSME sectors, Problems of MSME Sector, Sickness in MSMEs, Government policies on revival of sickness and remedial measures.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. B. R. Barringer and R. D. Ireland, *Entrepreneurship*, 2<sup>nd</sup> Edition, Pearson Education, 2008.
- T2. S. S. Khanka, *Entrepreneurial Development*, 4<sup>th</sup> Edition, S. Chand & Co., 2010.

T3. Z. Thomas and S. Norman, *Essentials of Entrepreneurship and Small Business Management*, 5<sup>th</sup> Edition, PHI Learning, 2009.

#### Reference Books:

- R1. P. Chavantimath, *Entrepreneurship Development and Small Business Enterprises*, 3<sup>rd</sup> Edition, Pearson Education, 2018.
- R2. H. D. Robert and P. M. Shephard, *Entrepreneurship*, 6<sup>th</sup> Edition, McGraw-Hill Education, 2007.
- R3. P. C. Jain, *Hand Book for New Entrepreneurs*, 4<sup>th</sup> Edition, Oxford University Press, 2004.
- R4. J. A. Timmons and S. Spinelli Jr., *New Venture Creation: Entrepreneurship for the 21st Century*, 8<sup>th</sup> Rev. Edition, Tata McGraw-Hill, 2009.
- R5. R. Roy, *Entrepreneurship Management*, 1<sup>st</sup> Edition, Oxford University Press, 2008.

#### Online Resources:

1. <https://nptel.ac.in/courses/110/106/110106141/>: by Prof. C. B. Rao, IIT Madras
2. <https://nptel.ac.in/courses/127/105/127105007/>: by Prof. M. K. Mondal, IIT Kharagpur
3. <https://nptel.ac.in/courses/110/107/110107094/>: by Prof. V. Sharma & Prof. R. Agrawal, IIT Roorkee

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the importance of entrepreneurship as a tool for development and discern distinct entrepreneurial traits.
CO2	Analyse the business environment to identify business opportunities and understand the systematic process to select and screen a business idea.
CO3	Prepare a proper business plan and project report.
CO4	Apply the tools necessary to create sustainable and viable businesses.
CO5	File and obtain patents for their innovative ideas to protect the rights of their business.

#### Program Outcomes Relevant to the Course:

PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9	<b>Individual and Team Work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO11	<b>Project Management and Finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2			2		3	1		2	1
CO2						1			2		3	1		2	3
CO3						1	2		2		3	1		1	2
CO4						2	2		2		3	1		1	2
CO5						2	2		2		3	1		3	3

Type	Code	Big Data Analytics	L-T-P	Credits	Marks
OE	18CS3T23			3-0-0	3

<b>Objectives</b>	The objective of the course is to study different techniques to find similar items, mining data streams, link analysis, clustering techniques, recommendation systems, and collaborative filtering used for Big Data, along with the concepts of batch processing, Hadoop, MapReduce & Spark.
<b>Pre-Requisites</b>	Knowledge of basics of data mining & algorithm design is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Introduction to Big Data, Data Management for Big Data, Data Exploration and Reproducibility, Data Quality; Introduction to Map Reduce, Map Reduce algorithm, patterns & relations, Parallel databases vs. Map Reduce, Storage solutions.	<b>7 Hours</b>
<b>Module-2</b>	Big Data Algorithms-I: Nearest Neighbor Search, Shingling of Documents, Similarity Preserving Summaries of Sets, Locality Sensitive Hashing for Documents, Distance Measures, Theory of Locality Sensitive Functions, LSH Families for High Degree of Similarities.	<b>9 Hours</b>
<b>Module-3</b>	Big Data Algorithms-II: Streaming Data Models, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Ones in Window, Page Rank, Efficient Computation of Page Rank, Topic Sensitive Page Rank.	<b>9 Hours</b>
<b>Module-4</b>	Big Data Algorithms-III: Clustering Techniques - BFR Algorithm, CURE Algorithm, Clustering in Non-Euclidean Space, Clustering for Streams and Parallelism; Matrix Factorization, Recommendation Systems and Collaborative Filtering.	<b>9 Hours</b>
<b>Module-5</b>	Introductions to Spark, Hadoop, Hive, Pig-Latin, Large Scale Visualization.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. J. Leskovec, A. Rajaraman, and J. D. Ullman, *Mining of Massive Datasets*, 2<sup>nd</sup> Edition, Cambridge University Press, 2014.
- T2. J. Bell, *Machine Learning for Big Data: Hands-On for Developers and Technical Professionals*, Wiley, 2014.

#### Reference Books:

- R1. J. Han, M. Kamber, and J. Pei, *Data Mining Concepts and Techniques*, 3<sup>rd</sup> Edition, Morgan Kaufman Publications, 2011.
- R2. T. M. Mitchell, *Machine Learning*, 1<sup>st</sup> Edition, McGraw-Hill Education, 2017.



**Online Resources:**

1. <https://nptel.ac.in/courses/106/106/106106142/>: by Prof. J. Augustine, IIT Madras
2. <https://nptel.ac.in/courses/106/104/106104189/>: by Dr. R. Misra, IIT Patna
3. <http://www.mmds.org>: Material on Mining of Massive Data Sets
4. <http://lintool.github.com/MapReduceAlgorithms/index.html>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the concepts of Big Data and Map Reduce techniques.
CO2	Apply different tools and techniques used for finding similar items.
CO3	Demonstrate application of algorithms for analysis of streaming data and link analysis.
CO4	Apply different techniques for recommendation systems & collaborative filtering and compare different clustering techniques to apply them for large dataset.
CO5	Explore the concepts of Hadoop, MapReduce, Spark and apply them to implement big data algorithms.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1							1	3	1	1
CO2	3	3	3	2	1							1	3	1	2
CO3	3	3	3	2	1							1	3	1	2
CO4	3	3	3	2	1							1	3	1	2
CO5	1	1	1	2	3							1	3	1	2

Type	Code	Artificial Intelligence	L-T-P	Credits	Marks
OE	18CS3T24		3-0-0	3	100

<b>Objectives</b>	The objective of the course is to provide a strong foundation of fundamental concepts and goals, methods & techniques of Artificial Intelligence (AI) to build intelligent systems with perception, reasoning, and learning abilities.
<b>Pre-Requisites</b>	Knowledge of basic mathematics, algorithms & data structures is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on problem solving activities.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	Artificial Intelligence: Introduction; Intelligent Agents: Agents and Environment, Good Behavior, Nature of Environments, Structure of Agents; Problem Solving: Solving Problems by Searching - Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed search strategies, Searching with Partial Information.	<b>8 Hours</b>
<b>Module-2</b>	Informed Search & Exploration: Informed (Heuristic) search strategies, Heuristic functions, Local Search Algorithms & Optimization Problems; Constraint Satisfaction Problems: Introduction, Backtracking search for CSPs, Local Search for CSPs; Adversarial Search: Games, Optimal Decisions in Games, Alpha-Beta Pruning; Knowledge & Reasoning: Knowledge-Based Agents, The Wumpus World.	<b>10 Hours</b>
<b>Module-3</b>	Knowledge and Reasoning: Logic, Propositional Logic, Reasoning Patterns in Propositional Logic; First-Order Logic: Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic; Inference in First-Order Logic: Propositional vs. First-Order Logic, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution; Knowledge Representation: Ontological Engineering , Categories and Objects, Semantic Nets, Frames.	<b>8 Hours</b>
<b>Module-4</b>	Planning: The Planning Problem, Planning with State-Space Search, Partial-Order Planning, Planning Graphs; Uncertain Knowledge & Reasoning: Acting under Uncertainty, Bayes Rule and its use; Probabilistic Reasoning: Representing Knowledge in an Uncertain Domain, Semantics of Bayesian Networks.	<b>8 Hours</b>
<b>Module-5</b>	Learning: Learning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees; Statistical Learning, Instance Based Learning, Neural Networks; Reinforcement Learning: Passive and Active Reinforcement Learning; Expert Systems: Introduction, Architecture, Representations.	<b>8 Hours</b>
<b>Total</b>		<b>42 Hours</b>

**Text Books:**

- T1. S. Russell and P. Norvig, *Artificial Intelligence - A Modern Approach*, 3<sup>rd</sup> Edition, Pearson Education, 2016.
- T2. D. W. Patterson, *Introduction to Artificial Intelligence & Expert Systems*, 1<sup>st</sup> Edition, Pearson Education, 2015.

**Reference Books:**

- R1. E. Rich, K. Knight, and S. B. Nair, *Artificial Intelligence*, 3<sup>rd</sup> Edition, McGraw Hill Education, 2009.
- R2. G. F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, 6<sup>th</sup> Edition, Pearson Education, 2008.
- R3. M. Negnevitsky, *Artificial Intelligence: A Guide to Intelligent Systems*, 3<sup>rd</sup> Edition, Addison Wesley, 2.
- R4. N. J. Nilson, *Principles of Artificial Intelligence*, Narosa, 2002.
- R5. E. Charniak and D. McDermott, *Introduction to Artificial Intelligence*, 1<sup>st</sup> Edition, Addison-Wesley, 1985.

**Online Resources:**

1. <https://nptel.ac.in/courses/106/102/106102220/>: by Prof. Mausam, IIT Delhi
2. <https://nptel.ac.in/courses/112/103/112103280/>: by Prof. S. M. Hazarika, IIT Guwahati
3. <https://nptel.ac.in/courses/106/106/106106140/>: by Prof. D. Khemani, IIT Madras
4. <https://nptel.ac.in/courses/106/106/106106126/>: by Prof. D. Khemani, IIT Madras
5. <https://nptel.ac.in/courses/106/105/106105079/>: by Prof. P. Dasgupta, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explore agents, environments, and search goal state using uninformed techniques in a state space.
CO2	Apply search techniques for game playing and solving constraint satisfaction problems.
CO3	Interpret logic, inference rules for decision making, and represent knowledge using semantic nets & frames.
CO4	Apply planning and reasoning to handle uncertainty in real life problems.
CO5	Use learning to solve complex real-life problems and design expert systems.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

*Cont'd...*

PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
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**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3								1	2	1	1
CO2	2	3	2	3								1	3	1	2
CO3	3	2	2	3								1	3	1	1
CO4	3	2	2	2		1						1	3	1	1
CO5	2	2	2	2		2						1	3	1	2

Type	Code	Industrial Instrumentation	L-T-P	Credits	Marks
OE	18EI3T25			3-0-0	3

<b>Objectives</b>	The objective of the course is to study the processes, characteristics, functionalities, instrument analysis, telemetry systems, and power plant instrumentation along with industrial hazards & safety considerations.
<b>Pre-Requisites</b>	Basic knowledge of Electronics, Electrical Engineering, Communication Engineering and Internet Technology is required.
<b>Teaching Scheme</b>	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on programming & applications.

### Evaluation Scheme

Teacher's Assessment			Written Assessment		Total
Quiz	Surprise Test(s)	Assignment(s)	Mid-Term	End-Term	
05	05	05	25	60	100

### Detailed Syllabus

Module-#	Topics	Hours
<b>Module-1</b>	<b>Introduction:</b> Functional Units, Classification, Performance Characteristics, Dynamic Calibration, Errors: An Overview, Statistical Error Analysis, Reliability and related topics; <b>Transducers:</b> Pressure Transducers - Electrical and vacuum type - Pirani gauge, Thermocouple gauge, Ionization gauge, Flow meter - Turbo-magnetic, Electromagnetic, Ultrasonic type, Level sensor - Electrical type (contact & non-contact).	<b>10 Hours</b>
<b>Module-2</b>	<b>Instruments for Analysis:</b> Introduction, Gas Analysers, Liquid Analysers, X-ray Methods, Chromatography - Gas and Liquid, Nuclear Magnetic resonance spectroscopy, Electron spin resonance spectroscopy, Mass spectroscopy, Sampling techniques.	<b>9 Hours</b>
<b>Module-3</b>	<b>Telemetry:</b> Introduction, Pneumatic Means, Electrical Means - voltage, position and synchro transmitters & receivers, Frequency Telemetry, Multiplexing, Modulation, Modulation of Digital Data, Types of Transmission Channels and characteristic, Briefing of a Telemetry System in Operation, Wireless I/O.	<b>8 Hours</b>
<b>Module-4</b>	<b>Power Plant Instruments:</b> Introduction, The Power Plant Scheme, Pressure, Temperature, Flow and Level, Vibration and Expansion, Analysis - Conductivity, Silica, Sodium, pH, DO, Turbidity and Hydrazine, Flue Gas Analysis.	<b>8 Hours</b>
<b>Module-5</b>	<b>Hazards and Safety:</b> Initial consideration, Enclosures - NEMA type, IP type, Intrinsic Safety, Prevention of Ignition, Methods of Production, Analysis Evaluation and Construction - Intrinsically safe installation, Unbalanced and balanced schemes.	<b>7 Hours</b>
<b>Total</b>		<b>42 Hours</b>

#### Text Books:

- T1. D. Patranabis, *Principle of Industrial Instrumentation*, 3<sup>rd</sup> Edition, McGraw-Hill, 2012.
- T2. R. S. Khandpur, *Handbook of Analytical Instruments*, 3<sup>rd</sup> Edition, Tata McGraw-Hill, 2015.

**Reference Books:**

- R1. B. G. Liptak, *Process Measurement and Analysis*, 3<sup>rd</sup> Edition, Chilton Book Company, 1995.
- R2. J. P. Bentley, *Principles of Measurement Systems*, 4<sup>th</sup> Edition, Pearson Education, 2005.
- R3. A. K. Ghosh, *Introduction to Instrumentation and Control*, 4<sup>th</sup> Edition, PHI Learning, 2012.
- R4. D. Patranabis, *Sensors and Transducers*, 2<sup>nd</sup> Edition, PHI Learning, 2010.
- R5. D. V. S Murthy, *Transducers and Instrumentation*, 4<sup>th</sup> Edition, PHI Learning, 2000.

**Online Resources:**

1. <https://nptel.ac.in/courses/108/105/10810506/>: by Dr.A. Barua, IIT Kharagpur
2. <https://nptel.ac.in/courses/108/105/108105062/>: by Prof. S. Mukhopadhyay and Prof. S. Sen, IIT Kharagpur
3. <https://nptel.ac.in/courses/108/105/108105088/>: by Prof. S. Mukhopadhyay, IIT Kharagpur

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Describe the characteristics of instruments and uses of transducers in industry.
CO2	Identify the instruments for the analysis of chemical composition in industry.
CO3	Explain the principles & working of telemetry systems and their industrial applications.
CO4	Describe the various components of power plant instrumentation and its usage.
CO5	Realize hazards in industry and practice safety principles in instrumentation.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	<b>Environment and Sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

P.T.O

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	1	2	1							1		
CO2	2	1	2	2	3		2						1		
CO3	2	2	2	2	2	1							1	1	2
CO4	2	3	2	2	1	2	1					1	1		
CO5	2	1	1	1	1	2	1	1					1	2	1

Type	Code	Digital Communication Lab	L-T-P	Credits	Marks
PC	18EC1L12			0-0-2	1

<b>Objectives</b>	The objective is to provide practical exposure on digital communication systems, focusing on TDM, Pulse modulations, Digital modulation techniques as well as PC data transmission through satellite link, spreading and despreading concepts.
<b>Pre-Requisites</b>	Basic knowledge of electronics and communication is required. The laboratory experiments shall go hand-in-hand with the topics taught in the theory class.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted under the supervision of the teacher. Demonstration will be given for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Study of Pulse Code Modulation.
2	Study of Time Division Multiplexing.
3	Study of the functioning of Delta modulator and Adaptive Delta Modulator.
4	Generation and reception of different types of signals like ASK, PSK, FSK.
5	Study of Quadrature-phase shift keying (QPSK).
6	Study of Quadrature Amplitude Modulation (QAM).
7	Transmit and receive three separate signals (audio, video, tone) simultaneously through satellite link.
8	Spreading and despreading using additive white Gaussian noise generation / Goldcode and other forms of spreading techniques.
9	Transmit PC data through satellite link using a satellite communication demonstration unit.
10	Study of Time Division Multiplexing and simulation of TDM using MATLAB.
11	Simulation of M-ary QAM and M-ary PSK using MATLAB.
12	Performance analysis of different digital modulation technique by using MATLAB.

#### Text Books:

- T1. H. Taub, D. L. Schilling, and G. Saha, *Principles of Communication Systems*, 4<sup>th</sup> Edition, McGraw Hill Education, 2013.
- T2. B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4<sup>th</sup> Edition, Oxford University Press, 2010.

#### Reference Books:

- R1. L. W. Couch II, *Digital and Analog Communication Systems*, 8<sup>th</sup> Edition, Pearson Education, 2013.
- R2. B. Sklar, *Digital Communication - Fundamentals and Applications*, 2<sup>nd</sup> Edition, Pearson Education, 2009.

#### Online Resources:

1. <https://nptel.ac.in/courses/117101051/>



2. <https://nptel.ac.in/courses/108/102/108102096/>
3. <https://nptel.ac.in/content/storage2/courses/117105077/pdf-m-7/m7l38.pdf>

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Convert analog to digital signal and vice-versa.
CO2	Transmit multiple signals using Time Division Multiplexing.
CO3	Realize different digital modulation schemes and their effect in communications with the help of spectrum analyzer.
CO4	Understand the functioning of satellite and how it is transmitting and receiving the signals.
CO5	Explain spreading concepts and methods to spread and disperse the given signals.

**Program Outcomes Relevant to the Course:**

PO1	<b>Engineering Knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
PO2	<b>Problem Analysis:</b> Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	<b>Design/Development of Solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	<b>Conduct Investigations of Complex Problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern Tool Usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	<b>The Engineer and Society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12	<b>Life-long Learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Mapping of COs to POs and PSOs (1: Low, 2: Medium, 3: High)**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		2	1								1	2		1
CO2	3	2	3	2		3						2	3	2	1
CO3	3	2	3	2	2	2						2	2	1	1
CO4	3	2	3	3	2	2						2	3	1	1
CO5	3			2		1						1	2	1	1

Type	Code	Emerging Technologies Lab	L-T-P	Credits	Marks
PC	18EC1L11			0-0-2	1

<b>Objectives</b>	The objective of this laboratory course is to provide practical exposure on latest & emerging tools & technologies of current demand in various electronics & communication engineering domains so as to make the students adapt to the fast-changing world of technology and make them ready for the industry.
<b>Pre-Requisites</b>	Knowledge of subjects taught in previous semesters is required. Additional topics (if any) required to perform the experiments shall be taught in the lab.
<b>Teaching Scheme</b>	Regular laboratory experiments to be conducted under the supervision of the teacher. Demonstration will be given for each experiment.

### Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test/ Mini Project	Viva-voce	Total
10	30	15	30	15	100

### Detailed Syllabus

Experiment-#	Assignment/Experiment
<b>Group A: Embedded System Design &amp; Simulation (any six)</b>	
1	To interface LED with ARM-7 and write program to flash LED.
2	To interface keys with ARM-7.
3	To interface seven segment display with ARM-7.
4	To interface LCD with ARM-7.
5	To interface relay with ARM-7.
6	To interface and control the speed of DC motor with ARM-7.
7	To interface stepper motor with ARM-7.
8	To interface ADC with ARM-7.
9	To interface ZIGBEE with ARM-7 to control more external device.
10	To interface RFID module with ARM-7.
<b>Group B: IoT System Design &amp; Implementation (any six)</b>	
1	Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2	To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3	To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4	To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5	To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6	To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.

*Cont'd...*

Experiment-#	Assignment/Experiment
7	To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8	To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9	Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
10	Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
11	To install MySQL database on Raspberry Pi and perform basic SQL queries.
12	Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
13	Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
14	Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
15	Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

**Text Books:**

- T1. K. V. Shibu, *Introduction to Embedded Systems*, 2<sup>nd</sup> Edition, McGraw-Hill Education, 2017.
- T2. R. Kamal, *Embedded Systems – Architecture, Programming and Design*, 12<sup>th</sup> Reprint, Tata McGraw-Hill, 2007.
- T3. A. Bahga and V. Madiseti, *Internet of Things : A Hands-On Approach*, 1<sup>st</sup> Edition, Universities Press, 2014.
- T4. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry, *IoT Fundamentals : Networking Technologies, Protocols, and Use Cases for the Internet of Things*, 1<sup>st</sup> Edition, Pearson Education, 2017.

**Reference Books:**

- R1. D. E. Simon, *An Embedded Software Primer*, Addison Wesley, 1999.
- R2. D. Kellmerit and D. Obodovski, *The Silent Intelligence : The Internet of Things*, 1<sup>st</sup> Edition, Lightning Source Inc., 2014.
- R3. M. Schwartz, *Internet of Things with Arduino Cookbook*, Packt Publishing, 2016.

**Online Resources:**

1. <https://nptel.ac.in/courses/106105159/>: By Prof A. Basu, IIT Kharagpur
2. <https://nptel.ac.in/courses/106/105/106105195/>: By Prof. S. Misra, IIT Kharagpur.
3. <https://nptel.ac.in/courses/108/108/108108098/>: By Prof. T. V. Prabhakar, IISc Bangalore
4. <https://nptel.ac.in/courses/108/105/108105064/>: By Prof. A. Barua, IIT Kharagpur
5. <https://nptel.ac.in/courses/106/104/106104189/>: By Dr. R. Misra, IIT Patna

**Course Outcomes:** *At the end of this course, the students will be able to:*

CO1	Explain the pin diagram of the ARM 7 processor.
CO2	Realize & conceive different applications using the ARM 7 processor.
CO3	Develop expertise on designing systems with Arduino/Raspberry Pi.
CO4	Use Arduino/Raspberry Pi for different practical applications.

**Program Outcomes Relevant to the Course:**

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CO2	3	3	2	3	3	1	1					2	3	1	2
CO3	3	3	2	3	3							2	3		1
CO4	2	2	2	3	3	1						2	2	1	2