Curriculum Structure & Detailed Syllabus

Master of Computer Applications (Integrated)

(5-Year Integrated BCA + MCA Program)

Silicon University

Silicon Hills, Patia, Bhubaneswar - 751024

Odisha, India.

https://silicon.ac.in

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Silicon University

Our Vision

To become a centre of excellence in the fields of technical education & research and create responsible citizens.

Our Mission

To provide the best of technical skills, professional ethics, and human values in enriching the disciplines of Science, Engineering and Technology for Social development and Nation building.

Approval History

ACM#	Date	Resolutions
SU-1	27/04/2024	The proposed curriculum structure of Integrated BCA + MCA (IMCA) was approved in principle by the Academic Council.
SU-2	17/08/2024	The curriculum structure of Integrated BCA + MCA (IMCA) and detailed syllabus of 1st Year was approved by the Academic Council.
SU-3	19/04/2025	The amendments to the curriculum structure of Integrated BCA + MCA (IMCA) and the detailed syllabus up to 2nd Year was approved by the Academic Council.
SU-5	07/02/2026	The detailed syllabus up to 3rd Year of Integrated BCA + MCA (IMCA) as recommended by the Board of Studies was approved by the Academic Council.
SU-6	01/08/2026	The detailed syllabus of 4th and 5th Year of Integrated BCA + MCA (IMCA) as recommended by the Board of Studies was approved by the Academic Council.

Program Outcomes

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.

PO1. Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.

PO2. Design and develop applications to analyze and solve all computer science related problems.

PO3. Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.

PO4. Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.

PO5. Integrate and apply efficiently the contemporary IT tools to all computer applications.

PO6. Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.

PO7. Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.

PO8. Communicate effectively and present technical information in oral and written reports.

PO9. Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.

PO10. Appreciate the importance of goal setting and to recognize the need for life-long learning.

Program Specific Outcomes (PSOs)

PSO1. Understand the concepts and applications in various fields of Computer Application like Web designing and development, Mobile application development, and Network & communication technologies.

PSO2. Apply standard practices and strategies in software development & project development using open-ended programming environments to deliver quality applications for business success.

PSO3. Employ modern computer languages, technologies, environments, and platforms in creating innovative career paths to be an entrepreneur, and a zest for higher studies.

Program Educational Objectives (PEOs)

PEO1. Develop software solutions to problems across a broad range of application domains through analysis and design.

PEO2. Work professionally and communicate effectively in interdisciplinary environment, either independently or in team, and demonstrate leadership in academia and industry.

PEO3. Utilize computational techniques and develop software by integrating existing technologies and adapt to new technologies for building rich software applications for benefit of the society.

Course Categories & Definitions

L	Lecture
T	Tutorial
P	Practical / Laboratory / Sessional
WCH	Weekly Contact Hours
UCR	University Core Course
UMC	University Mandatory Course (0-Credit)
PCR	Program Core Course
PEL	Program Elective Course
OEL	Open Elective Course
HNS	Honours (Choice-based) Course
MNR	Minor (Choice-based) Course
OOC	Open Online Course (on NPTEL / Swayam / Other)
INT	Summer Internship
PSI	Practice School / Industry Internship
PRJ	Project Work
SEC	Skill Enhancement Course
VAC	Value Addition Course

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Part I

Curriculum Structure

Curriculum Structure

1st Year Integrated BCA + MCA

Semester I									
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY									
UCR	MG1001	Financial Accounting	3	0	0	3	0	0
UCR	CH1002	Environmental Science & Sustainability	3	0	0	3	0	0
PCR	EC1003	Electronics & Semiconductor Devices	3	0	0	3	0	0
PCR	EC1004	Digital Logic & Computer Design	3	0	0	3	0	0
PCR	CS1005	Computer Programming - I	3	0	0	3	0	0
PRACTICAL								
PCR	EC1005	Digital Logic & Computer Design Lab	0	0	2	0	0	1
PCR	CS1006	Computer Programming - I Lab	0	0	2	0	0	1
PCR	CS1007	Office Productivity Tools Lab	0	0	2	0	0	1
SEC	HS1001	Communicative & Technical English	0	0	4	0	0	2
		SUB-TOTAL	**15**	**0**	**10**	**15**	**0**	**5**
		TOTAL	**25**			**20**		

Semester II									
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY									
UCR	MT1003	Linear Algebra & Numerical Methods	3	0	0	3	0	0
UCR	BL1001	Biology for Computer Applications	3	0	0	3	0	0
PCR	EC1006	Microprocessors & Microcontrollers	3	0	0	3	0	0
PCR	CS1008	Computer Programming - II	3	0	0	3	0	0
PCR	CS1009	Web Design with HTML & CSS	3	0	0	3	0	0
PRACTICAL								
PCR	CS1010	Microprocessors & Microcontrollers Lab	0	0	2	0	0	1
PCR	CS1011	Computer Programming - II Lab	0	0	2	0	0	1
PCR	CS1012	Web Design with HTML & CSS Lab	0	0	2	0	0	1
SEC	HS1002	Corporate Communication Skills	0	0	4	0	0	2
		SUB-TOTAL	**15**	**0**	**10**	**15**	**0**	**5**
		TOTAL	**25**			**20**		

2nd Year Integrated BCA + MCA

Semester III								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	MT2005	Discrete Mathematics	3	1	0	3	1	0
UCR	MG2003	Principles of Management	3	0	0	3	0	0
PCR	CS2017	Data Structures Using C	3	1	0	3	1	0
PCR	CS2019	Object Oriented Programming in C++	3	0	0	3	0	0
PCR	CS2021	Interactive Web Development	3	0	0	3	0	0
PRACTICAL								
PCR	CS2018	Data Structures Using C Lab	0	0	4	0	0	2
PCR	CS2020	Object Oriented Programming in C++ Lab	0	0	2	0	0	1
PCR	CS2022	Interactive Web Development Lab	0	0	2	0	0	1
INT	IP2001	Summer Internship - I	0	0	0	0	0	1
		SUB-TOTAL	**15**	**2**	**8**	**15**	**2**	**5**
		TOTAL	**25**			**22**		

Semester IV								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	MT2006	Probability & Statistics	3	1	0	3	1	0
UCR	MG2004	Managerial Economics	3	0	0	3	0	0
PCR	CS2023	Java Programming	3	1	0	3	1	0
PCR	CS2002	Design & Analysis of Algorithms	3	1	0	3	1	0
UMC	HS2001	Constitution of India	2	0	0	0	0	0
PRACTICAL								
PCR	CS2024	Java Programming Lab	0	0	4	0	0	2
PCR	CS2005	Design & Analysis of Algorithms Lab	0	0	2	0	0	1
SEC	HS2002	Soft Skills & Technical Writing	0	0	4	0	0	2
		SUB-TOTAL	**14**	**3**	**10**	**12**	**3**	**5**
		TOTAL	**27**			**20**		

3rd Year Integrated BCA + MCA

Semester V								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	CS3031	Operating Systems	3	0	0	3	0	0
PCR	CS3032	Database Management Systems	3	1	0	3	1	0
PCR	CS3033	Artificial Intelligence	3	0	0	3	0	0
PCR	CS3034	Software Engineering	3	0	0	3	0	0
UCR	HS3003	Organizational Behaviour	3	0	0	3	0	0
PRACTICAL								
PCR	CS3035	Operating Systems Lab	0	0	2	0	0	1
PCR	CS3036	Database Management Systems Lab	0	0	4	0	0	2
PCR	CS3037	Programming in Python Lab	0	0	4	0	0	2
INT	IP3003	Summer Internship - II	0	0	0	0	0	1
		SUB-TOTAL	**15**	**1**	**10**	**15**	**1**	**6**
		TOTAL	**26**			**22**		

Semester VI								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	MT3002	Operations Research	3	0	0	3	0	0
PCR	CS3038	Computer Networks	3	0	0	3	0	0
PCR	CS3039	Computer Organization & Architecture	3	0	0	3	0	0
PEL		Program Elective - I	3	0	0	3	0	0
UMC	HS0002	Human Values & Professional Ethics	2	0	0	0	0	0
PRACTICAL								
PCR	CS3040	Computer Networks Lab	0	0	2	0	0	1
PCR	CS3041	Computer Organization & Architecture Lab	0	0	2	0	0	1
PCR	CS3042	Mobile Application Development Lab	0	0	4	0	0	2
PRJ	IP3004	Project - I	0	0	12	0	0	6
		SUB-TOTAL	**14**	**0**	**20**	**12**	**0**	**10**
		TOTAL	**34**			**22**		

Note:
If a student opts to exit the Integrated MCA program after successful completion of the 3rd Year, then s/he shall be awarded with only a Bachelor in Computer Applications (BCA) degree as per the provisions of the Academic Regulations of Silicon University.

4th Year Integrated BCA + MCA

Semester VII								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	CS4001	Soft Computing	3	0	0	3	0	0
PCR	CS4002	Internet of Things	3	0	0	3	0	0
PCR	CS4003	OOAD & Patterns Using UML	3	0	0	3	0	0
PCR	CS4004	Advanced Java Programming	3	1	0	3	1	0
PEL		Program Elective - II	3	0	0	3	0	0
PRACTICAL								
PCR	CS4005	Soft Computing Lab	0	0	2	0	0	1
PCR	CS4006	Internet of Things Lab	0	0	2	0	0	1
PCR	CS4007	OOAD & Patterns Using UML Lab	0	0	2	0	0	1
PCR	CS4008	Advanced Java Programming Lab	0	0	4	0	0	2
INT	IP4005	Summer Internship - III	0	0	0	0	0	1
		SUB-TOTAL	**15**	**1**	**10**	**15**	**1**	**6**
		TOTAL	**26**			**22**		

Semester VIII								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
PCR	CS4009	Cryptography & Internet Security	3	1	0	3	1	0
PCR	CS4010	Web Application Development	3	1	0	3	1	0
PEL		Program Elective - III	3	0	0	3	0	0
PEL		Program Elective - IV	3	0	0	3	0	0
UCR	CS4011	Entrepreneurship Development	3	0	0	3	0	0
PRACTICAL								
PCR	CS4012	Web Application Development Lab	0	0	4	0	0	2
SEC	IP4014/ IP4015	Emerging Technologies Lab/ Entrepreneurship & Innovation	0	0	4	0	0	2
PCR	IP4018	Presentation Skills & Technical Seminar	0	0	2	0	0	1
VAC	VA0001	Yoga / NSS / NCC / PES / CPA *	0	0	2	0	0	0
		SUB-TOTAL	**15**	**2**	**12**	**15**	**2**	**5**
		TOTAL	**29**			**22**		

***Value Addition Courses**: Yoga - Yoga & Meditation, NSS - National Service Scheme, NCC - National Cadet Corps, PES - Physical Education & Sports, CPA - Creative & Performing Arts. Every student must invest at least 2 hours per week in the chosen course in one semester.

5th Year Integrated BCA + MCA

Semester IX								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
OOC	CS5049	MOOC - I	0	0	0	3	0	0
PRACTICAL								
PRJ/PSI	IP5001	Project - II / Industry Internship - I	0	0	24	0	0	12
		SUB-TOTAL	**0**	**0**	**24**	**3**	**0**	**12**
		TOTAL	**24**			**15**		

Semester X								
Category	**Code**	**Course Title**	**WCH** L-T-P			**Credits** L-T-P		
THEORY								
OOC	CS5050	MOOC - II	0	0	0	3	0	0
PRACTICAL								
PRJ/PSI	IP5002	Project - III / Industry Internship - II	0	0	24	0	0	12
		SUB-TOTAL	**0**	**0**	**24**	**3**	**0**	**12**
		TOTAL	**24**			**15**		

		GRAND TOTAL (10 SEMESTERS)	**264**	**200**

Note:

1. Courses offered under each elective are given in “List of Electives” on Page 7.
2. MOOC - Massive Open Online Course (on NPTEL / Swayam / Other).
3. Approved list of courses for MOOC (self study) shall be published by the department. Students are advised to complete and pass the same before the end of the final semester.
4. Students opting for Project Work shall undergo the same under the guidance of a faculty member.
5. Students selected for Industry Internship shall be attached to a faculty member as mentor.
6. The Value Addition Course (Yoga / NSS / NCC / PES / CPA) may be assigned in a different semester depending on available capacity.

List of Electives

Code	Elective # and Subjects
	Program Elective - I
CS3043	Data Mining & Data Warehousing
CS3044	Simulation & Modelling
CS3045	Mobile Computing
	Program Elective-II
CS4013	Natural Language Processing
CS4014	Theory of Computation
CS4015	Realtime Systems
	Program Elective-III
CS4016	Machine Learning
CS4017	Compiler Design
CS4018	Cloud Computing
	Program Elective-IV
CS4019	Software Testing
CS4020	Software Project Management
CS4021	E-Commerce & Knowledge Management
CS4022	Computer Graphics

Note:

1. The list of electives may be modified as per the recommendation of the Board of Studies.
2. The department shall offer subjects under each program elective depending on available capacity.
3. Unless adequate number of students choose an elective subject offered by the department, the subject shall not be offered and the students shall be assigned with a different elective subject.

Part II

Detailed Syllabus

Category	Code	Financial Accounting	L-T-P	Credits	Marks
UCR	MG1001		3-0-0	3	100

Objectives	To provide basic knowledge of financial accounting and equip the students with the knowledge of accounting process and preparation of final accounts.
Pre-Requisites	Basic knowledge of day to day transactions of any business organization.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Fundamentals of Accounting: Accounting as a business function and language of business, Functions and objectives of Accounting, Users of Accounting information, Limitations of Accounting, Cyclical nature of business and Accounting cycles, Accounting concepts – as applicable to Balance sheet and Income Statements, The rule of debit and credit.	**7 Hours**
Module-2	Accounting equations, Accounting events and transactions, Classification of transaction and their effect on Accounting Equation, Statement showing the effect of transaction on assets, liabilities and capital, Capital and revenue transactions, Fixed assets and depreciation policy and methods.	**8 Hours**
Module-3	Recording of transaction: The journal, The ledger postings, Subsidiary Books of Accounts: purchase books, sales books, Cash books.	**7 Hours**
Module-4	Preparation of Financial Statements of a sole trader: Trial balance, Trading Account, Manufacturing Account, Profit and Loss account, Balance sheet with basic adjustments.	**10 Hours**
Module-5	Company Accounts: Types of Companies - Private sector, Public sector, Private limited, public limited, Govt. company, holding company and subsidiary company, Capital and types of capital - Authorized Share Capital, Subscribed, issued, paid up share capital, Shares - Equity Shares, Preference shares and types of preference shares, Issue of share capital and treatment of books of Accounts, Journal entries for issue only (forfeiture of shares excluded).	**10 Hours**
	Total	**42 Hours**

Text Books:

T1. A. Dash, S. Sahu, and R. K. Bal, ***A New Approach to Financial Accounting for Professional Student***, S. Chand Publication, 2010.
T2. S. P. Jain and K. L. Narang, ***Financial Accounting***, Latest Edition, Kalyani Publishers.

Reference Books:

R1. A. K. Bhattacharya, ***Financial Accounting***, Latest Edition, Prentice Hall of India.
R2. S. N. Maheshwari, Sharad K. Maheshwari, and Suneel K. Maheshwari, ***Principles of Financial Accounting***, Vikas Publishing, 2013.

Online Resources:

1. https://www.mbacrystalball.com/blog/accounting/financial-accounting/
2. https://www.myaccountingcourse.com/accounting-basics/financial-accounting
3. http://accounting-simplified.com/financial/fixed-assets/capital-and-revenue-expenditure.html
4. https://accountlearning.com/understanding-various-types-of-assets-and-liabilities/
5. https://syskool.com/a-company-definition-features/

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

CO1	Understand the concepts of accounting and its application in engineering projects.
CO2	Determine the effects of a transaction on assets, liabilities and capital.
CO3	Apply financial record keeping principles in creating accounting software systems.
CO4	Apply the methods of profit & loss computation of an organization in software systems.
CO5	Manage shares and market position of the company by use of computer applications.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Environmental Science & Sustainability	L-T-P	Credits	Marks
UCR	CH1002		3-0-0	3	100

Objectives	The objective of this course is to sensitize the students with essential knowledge of environment & sustainability including pollution, laws, management of solid, hazardous, and e-waste for enhancing long-term sustainability.
Pre-Requisites	Basic knowledge of physics, chemistry and biology is adequate.
Teaching Scheme	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

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Ecology, Ecosystems & Biogeochemical Cycles**: Introduction, Ecological perspective, Ecosystems and processes, Trophic pyramids, Biodiversity of species, Water, Oxygen, Nitrogen and Carbon cycle, Environmental gradient and tolerance levels of environmental factors.	**9 Hours**
Module-2	**Water and Waste-Water Treatment**: Water quality standards and parameters, Water table, Aquifer, Pre-treatment, Conventional treatment processes of Water, DO, BOD, COD and Microbial Waste-Water treatment.	**8 Hours**
Module-3	**Atmosphere, Soil and Noise**: Atmospheric chemistry, Air pollution and associated control equipment, Climate change, Soil chemistry, Noise standards, Noise measurement and noise abatement.	**8 Hours**
Module-4	**Waste Management**: Types and management of MSW (Municipal Solid Waste), Hazardous waste and e-waste, Life Cycle Assessment (LCA).	**8 Hours**
Module-5	**Sustainability**: Sustainable Development Goals (SDGs), Environmental audit, EIA (Environmental Impact Assessment), EIS (Environmental Impact Statement), Indian environmental laws, UN conferences, Human population and the environment.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. G. M. Masters and W. P. Ela, ***An Introduction to Environmental Engineering and Science***, 3rd *Ed.*, PHI Learning, 2015.
T2. G. Kiely, ***Environmental Engineering***, Spl. Indian Edition, McGraw-Hill, 2007.

Reference Books:

R1. M. L. Davis and S. J. Masten, ***Principles of Environmental Engineering and Science***, 2nd *Ed.*, McGraw-Hill, 2017.
R2. H. D. Kumar and U. N. Dash, ***Environmental Studies***, 2nd *Ed.*, IndiaTech Publishers, 2017.

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	Describe the concepts of ecology, ecosystems, and biogeochemical cycles in the environment.
CO2	Explain the process of water and wastewater treatment for prevention of water pollution.
CO3	Understand the pollutants in the environment and explore the principles for their eradication.
CO4	Explore waste minimization and management of different types of wastes generated.
CO5	Understand various environmental laws for sustainability and prevention of pollution.

Program Outcomes Relevant to the Course:

PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Electronics & Semiconductor Devices	L-T-P	Credits	Marks
PCR	EC1003		3-0-0	3	100

Objectives	The objectives of this course is to introduce the students to the concepts of basic electricity, semiconductors, construction, characteristics of diodes, different types of transistors and Op-Amps in electronic circuits for various applications.
Pre-Requisites	Basic knowledge of physics and mathematics of 12th class level is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Electric current, Resistance, Ohm's Law, Series & parallel combination of resistances, Kirchoff's current & voltage laws, Thevenin's theorem, Norton's Theorem, Superposition Theorem and Maximum Power Transfer Theorem, Alternating Current (AC) and Direct Current (DC), Instantaneous, Average and RMS values of AC.	**8 Hours**
Module-2	Classification of solids, Semiconductor, Intrinsic and extrinsic semiconductors, n-type and p-type semiconductors, p-n junction diode, V-I characteristics, Forward and reverse resistances of diode, Rectifiers – half wave and full wave, Zener diode as a voltage regulator.	**8 Hours**
Module-3	Bipolar Junction Transistors (BJT), Characteristics of Common-base, Common-emitter and Common-collector configurations, Comparison – Transistor as an amplifier (CE), Transistor Biasing – Fixed biased and voltage divider bias method.	**8 Hours**
Module-4	Field Effect Transistors (FET), Construction, Types of FET – Junction field effect transistor (JFET), Working of JFET, Metal Oxide Semiconductor FET (MOSFET), Construction, Operation and static V-I characteristics of Depletion type and Enhancement type MOSFET.	**9 Hours**
Module-5	Feedback Amplifier, Positive and Negative feedback amplifiers (Qualitative study only), Applications of Op-Amp – Inverting, Non-inverting, Differential amplifier, Summing amplifier, Integrator and differentiator; Oscillators – Conditions for oscillation, Types of oscillator – RC phase shift, Wien Bridge Oscillator.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. R. L. Boylestad and L. Nashelsky, ***Electronic Devices and Circuit Theory***, 11th *Ed.*, Pearson Education, 2013.

T2. A. S. Sedra and K. C. Smith, ***Microelectronic Circuits***, 7th *Ed.*, Oxford University Press, 2014.

T3. B. L. Theraja and A. K. Theraja, ***Textbook of Electrical Technology***, Vol-I, 23rd *Ed.*, S. Chand & Co.Ltd., 2002.

Reference Books:

R1. A. Agarwal and J. Lang, ***Foundations of Analog and Digital Electronic Circuits***, 1st *Ed.*, Morgan Kaufmann, 2005.
R2. V. K. Mehta and R. Mehta, ***Principles of Electronics***, 3rd *Ed.*, S. Chand Publishing, 1980.

Online Resources:

1. https://nptel.ac.in/courses/117/103/117103063/: by Prof. G. Barua, IIT Guwahati
2. https://nptel.ac.in/courses/108/101/108101091/: By Prof. M. B. Patil, IIT Bombay
3. https://nptel.ac.in/courses/122/106/122106025/: By Prof. T. S. Natarajan, IIT Madras
4. https://nptel.ac.in/courses/117/107/117107095/: Web Content by IIT Roorkee
5. https://nptel.ac.in/courses/122/104/122104013/: Web Content by IIT Kanpur

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

CO1	Differentiate between DC and AC sources and analyze various types of electrical networks.
CO2	Design different rectifier circuits using diodes for various applications.
CO3	Apply transistors in different configurations and biasing in various electronic circuits.
CO4	Compare the operation and characteristics of JFET and MOSFET with different biasing.
CO5	Analyze the characteristics of Op-Amp and design circuits using them for various applications.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Digital Logic & Computer Design	L-T-P	Credits	Marks
PCR	EC1004		3-0-0	3	100

Objectives	The objective of this course is to develop an understanding of the concepts and techniques associated with the digital electronics systems and their application in designing modern computer systems.
Pre-Requisites	Basic knowledge of number systems and electronics is required.
Teaching Scheme	Regular class room lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Number System and their Conversion, Arithmetic Operation using 1's and 2's compliments, Logic Gates, Universal Logic Gates, Boolean Algebra and De Morgan's Theorem; Realization of Boolean Function using logic gates, Universal Logic Gates, Binary codes, their application and Code Conversion.	**8 Hours**
Module-2	Boolean Function Simplification, SOP & POS forms, Min term, Max term, Canonical forms, Karnaugh maps up to 4 variables, Combinational Logic Design – Half and Full Adders and Subtractors, Multipliers, Digital Comparators, Multiplexers, De-Multiplexors, Encoder and Decoder.	**9 Hours**
Module-3	Sequential Logic Design, Flip Flops – 1-bit memory, The clocked S-R, J-K, T and D Flip Flop, Race around Condition, Master-Slave JK Flip Flop, Triggering of Flip Flop, Conversion between the Flip Flop, Ripple, Synchronous and Mod-N Counters.	**8 Hours**
Module-4	Shift Registers and Counters, Shift Registers SISO, SIPO, PISO, PIPO, Universal Shift Register, Applications of Shift Registers Ring Counter, Twisted Ring Counter (Johnson Counter); Design of Synchronous Counters, Gray Code and Random Sequence Counters using State Diagrams; Finite State Machines (FSMs)– Mealy and Moore models of Finite State Machines.	**9 Hours**
Module-5	Programmable Logic Devices, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Semiconductor Memories – Basics of ROM, SRAM and DRAM.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. A. A. Kumar, ***Fundamentals of Digital Circuits***, 3rd *Ed.*, PHI Learning, 2014.
T2. M. M. Mano, ***Digital Logic and Computer Design***, 1st *Ed.*, Pearson Education, 2016.

Reference Books:

R1. D. V. Hall, ***Digital Circuits and Systems***, International Student Edition, McGraw-Hill Education, 1989.
R2. W. H. Gothmann, ***Digital Electronics - An Introduction to Theory and Practice***, 2nd *Ed.*, PHI Learning, 1982.
R3. R. P. Jain, ***Modern Digital Electronics***, 4th *Ed.*, McGraw-Hill Education, 2009.

Online Resources:

1. https://nptel.ac.in/courses/117106086/: by Prof. S. Srinivasan, IIT Madras
2. https://nptel.ac.in/courses/117103064/: Prof. A. Mahanta and Prof. R. P. Palanthinkal, IIT Guwahati
3. https://nptel.ac.in/courses/117105080/: by Prof. D. Roychoudhury, IIT Kharagpur
4. https://swayam.gov.in/course/1392-digital-circuits-and-systems
5. http://www.allaboutcircuits.com

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

CO1	Represent numbers under various number systems and convert one number system to another.
CO2	Simplify any function and implement in the lab using universal logic gates.
CO3	Design various sequential logic circuits and be familiar with counter design.
CO4	Design digital circuits in real time applications including digital watch, digital displays.
CO5	Differentiate between various memory chips and Interface external memory to devices.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Programming - I	L-T-P	Credits	Marks
PCR	CS1005		3-0-0	3	100

Objectives	The objectives of this course is to introduce the fundamentals of computer programming and provide exposure to problem-solving through computer programs written using the C Programming language.
Pre-Requisites	Basic analytical and logical understanding including basic knowledge and usage of computers is required for this course.
Teaching Scheme	Regular classroom lectures with the use of ICT as and when required; sessions are planned to be interactive with problem-solving and programming activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Computer Fundamentals**: Definition, Characteristics, Computer Hardware – Major components, Block diagram, Input-output devices, CPU, Memory, Computer Software – System software, Operating system, Assemblers, Compilers, Interpreters, Linkers, Loaders, Application Software, Evolution of programming languages, Algorithms, Flowchart.	**8 Hours**
Module-2	**Programming in C**:Structure of a C program, Character set, Identifier, Keywords, Constants, Variables, Fundamental data types, Operators, Expressions, Statements, Operator precedence and associativity, Type conversion, Input/output statements, Formatted input & output.	**9 Hours**
Module-3	**Decision Making & Branching**: Basic concepts, if, if-else, Nested if-else, if-else-if ladder, The switch-case construct, Iterative execution using loops – while, for, do-while, Nested loops, Controlling loop behavior – break, continue, goto, and exit.	**9 Hours**
Module-4	**Arrays (1-D & 2-D)**: Derived data type, Declaration, initialization, and accessing array elements, Operations on 1-D arrays – Insertion, Deletion, Searching, Sorting, Merging, etc., Operations on 2-D arrays, Multi-dimensional arrays.	**8 Hours**
Module-5	**Functions in C**: Monolithic vs Modular programming, Library functions vs User-defined functions, Functions in C – function prototype, function definition, function call, parameter passing, Recursion, Storage classes.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. P. K. Sinha and P. Sinha, ***Computer Fundamentals***, 6th *Ed.*, BPB Publications, 2004.
T2. E. Balagurusamy, ***Programming in ANSI C***, 7th *Ed.*, McGraw-Hill Education, 2017.
T3. Y. Kanetker, ***Let Us C***, 16th *Ed.*, BPB Publications, 2018.

Reference Books:

R1. R. Thareja, ***Programming in C***, 2nd *Ed.*, Oxford University Press, 2006.
R2. B. W. Kernighan and D. M. Ritchie, ***The C Programming Language***, 2nd *Ed.*, Pearson Education, 2015.
R3. H. Schildt, ***C: The Complete Reference***, 4th *Ed.*, McGraw-Hill, 2017.

Online Resources:

1. https://nptel.ac.in/courses/106105171/: by Prof. A. Basu, IIT Kharagpur
2. https://nptel.ac.in/courses/106102066/: by Prof. S. A. Kumar, IIT Delhi
3. https://nptel.ac.in/courses/106104074/: by Prof. D. Gupta, IIT Kanpur
4. https://www.cs.uic.edu/~jbell/CourseNotes/C_Programming/
5. http://www.stat.cmu.edu/~hseltman/c/CTips.html
6. https://www.learn-c.org/
7. https://c-faq.com/

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

CO1	Explain the basics of a computer system and express the logic of a problem using flowcharts.
CO2	Write C programs for simple problems with proper inputs and display formatted output.
CO3	Develop structured C programs with branching and looping using appropriate constructs.
CO4	Solve problems involving 1-D and 2-D arrays and write programs to operate on them.
CO5	Design modular C programs using functions and solve problems using recursive approach.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Digital Logic & Computer Design Lab	L-T-P	Credits	Marks
PCR	EC1005		0-0-2	1	100

Objectives	The objective of the course is to understand the internal structure of logic gates, their implementation using Boolean algebra, designof digital circuits like counters and registers and their application in modern computer systems.
Pre-Requisites	Basic knowledge of digital electronics is required.
Teaching Scheme	Regular laboratory experiments to be conducted under supervision of the faculty with use of ICT as and when required, with the focus on implementation using hardware and software tools.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Digital Logic Gates: Investigate logic behavior of AND, OR, NAND, NOR, EX-OR, EX-NOR, Invert, Buffer gates and use of Universal NAND Gate.
2	Gate-level minimization: Two level and multi level implementation of Boolean functions.
3	Combinational Circuits: Design, assemble and test: adders and subtractors (Half and Full).
4	Code Converters, Gray code to Binary and Binary to Gray code.
5	BCD to 7-segment Decoder/Display.
6	Design, implement and test a given design example with: (a) NAND Gates only, (b) NOR Gates only and (c) Using minimum number of Gates.
7	Design with multiplexers and de-multiplexers.
8	Flip-Flop: assemble, test and investigate operation of SR, T, D and J-K Flip-Flops.
9	Shift Registers: Design and investigate the operation of all types of shift registers with parallel load.
10	Counters: Design, assemble and test various ripple and synchronous Counters- decimal counter and Binary Counter with parallel load.
11	Memory Unit: Investigate behavior of RAM and its storage capacity – 16×4 RAM: testing, simulating and memory expansion.
12	Clock-pulse generator: design, implement and test.
13	Parallel adder and accumulator: design, implement and test.
14	Binary Multiplier: design and implement a circuit that multiplies 4-bit unsigned numbers to produce a 8-bit product.

Text Books:

T1. A. A. Kumar, ***Fundamentals of Digital Circuits***, 3rd *Ed.*, PHI Learning, 2014.
T2. M. M. Mano, ***Digital Logic and Computer Design***, 1st *Ed.*, Pearson Education, 2016.

Reference Books:

R1. D. V. Hall, ***Digital Circuits and Systems***, International Student Edition, McGraw-Hill Education, 1989.

R2. W. H. Gothmann, ***Digital Electronics - An Introduction to Theory and Practice***, 2nd *Ed.*, PHI Learning, 1982.
R3. R. P. Jain, ***Modern Digital Electronics***, 4th *Ed.*, McGraw-Hill Education, 2009.

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/

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

CO1	Analyze the function of logic gates and implement Boolean functions.
CO2	Explain universal gates and implement Boolean expressions using the same.
CO3	Design and analyze different combinational circuits.
CO4	Design various asynchronous and synchronous circuits.
CO5	Explore the internal circuitry and logic behind any digital computer system.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Programming - I Lab	L-T-P	Credits	Marks
PCR	CS1006		0-0-2	1	100

Objectives	The objective of the course is to understand the internal structure of logic gates, their implementation using Boolean algebra, designof digital circuits like counters and registers and their application in modern computer systems.
Pre-Requisites	Basic knowledge of C programming language is required.
Teaching Scheme	Regular laboratory classes are conducted under the supervision of the teacher. The experiments shall comprise of programming assignments.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to Linux operating system, Linux commands.
2	Introduction to the vi editor, using vi editor to write programs.
3	Compilation and execution of simple C programs with arithmetic operators.
4	Programs using relational, logical, and conditional operators.
5	Formulate problems on Decision-making statements using if-else and nested if-else.
6	Implement decision-making statements using switch-case constructs.
7	Implement loop-control structures using while, do-while, and for loops.
8	Programs on loop-control structures using nested loops.
9	Programs on control transfer statement using break, continue, goto.
10	Programs on 1-dimensional array operations.
11	Programs on 2-dimensional array operations.
12	Programs on functions using call by value.
13	Programs on functions using recursion.
14	Programs on storage classes and study of their effects.

Text Books:

T1. E. Balagurusamy, ***Programming in ANSI C***, 7th *Ed.*, McGraw-Hill Education, 2017.
T2. M. Sprankle and J. Hubbard, ***Problem Solving and Programming Concepts***, 9th *Ed.*, Pearson Education, 2011.

Reference Books:

R1. B. W. Kernighan and D. M. Ritchie, ***The C Programming Language***, 2nd *Ed.*, PHI, 2012.
R2. H. M. Deitel and P. J. Deitel, ***C How to Program***, 3rd *Ed.*, Pearson Education Asia,2001.
R3. H. Schildt, ***C: The Complete Reference***, 4th *Ed.*, McGraw-Hill Education, 2017.

Online Resources:

1. https://nptel.ac.in/courses/106105171/: by Prof. A. Basu, IIT Kharagpur
2. https://nptel.ac.in/courses/106102066/: by Prof. S. A. Kumar, IIT Delhi
3. https://nptel.ac.in/courses/106104074/: by Prof. D. Gupta, IIT Kanpur
4. https://www.cs.uic.edu/~jbell/CourseNotes/C_Programming/
5. http://www.stat.cmu.edu/~hseltman/c/CTips.html

6. https://www.learn-c.org/
7. https://c-faq.com/

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

CO1	Write C programs using variables, expressions, and input/output statements.
CO2	Formulate the logic of a problem using relational, logical, and conditional operators.
CO3	Develop structured C programs involving decision-making and different control constructs.
CO4	Develop C programs to solve problems involving a similar set of data items using arrays.
CO5	Construct modular C programs using functions for better maintenance and reusability.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Office Productivity Tools Lab	L-T-P	Credits	Marks
PCR	CS1007		0-0-2	1	100

Objectives	The objective of this laboratory course is to provide practical exposure on common office productivity software for creating documents, spreadsheets, presentations, email, and other modern tools used in daily life of a computer professional.
Pre-Requisites	Basic knowledge of using computers is adequate for this course.
Teaching Scheme	Regular laboratory classes conducted under the supervision of the teacher; the experiments shall comprise of assignments on different office productivity tools.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Working with MS Word documents, basic formatting, fonts, bullets & numbering, page setup & margins, indentation, multiple columns, tables, alignment & spacing.
2	Spelling & grammar checking, working with layout and borders in a Word document.
3	Working with objects, inserting text boxes, pictures, shapes, clip arts, etc.
4	Page breaks & section breaks, headers & footers, different types of views.
5	Working with MS Excel, basics of spreadsheet & workbook, working with multiple sheets, creating, opening, saving, and closing of a workbook.
6	Rows and columns in a sheet, resizing and inserting new rows and columns, inserting different types of data, formatting of data.
7	Cell reference, absolute & relative reference, ranges, entering formula, basic formulae, auto-fill, fill handle, referencing cells in a different file.
8	Sorting and filtering of data in a spreadsheet, conditional formatting.
9	Working with formulae, data analysis and manipulation, working with Pivot Table.
10	Creating charts from data, borders, page layout, and margins, printing of a spreadsheet.
11	Working with MS PowerPoint, Creating slides, basic formatting, layout, and designs.
12	Enhancing slides with clip arts, pictures, and SmartArt, themes and masters.
13	Enhancing slides with animation, transitions, multimedia, delivering a presentation.
14	Creating group e-mail IDs, working with Google Forms and Google Sheets

Text Books:

T1. S. Jain, ***Computer Course: Windows 10 with MS Office 2016***, 1st *Ed.*, BPB Publications, 2018.
T2. V. P. Singh, ***Quintessential Course on MS Office 2016***, 1st *Ed.*, Computech Publications, 2016.

Reference Books:

R1. R. Arora, ***Mastering Advanced Excel***, BPB Publications, 2023.
R2. M. Nigam, ***Data Analysis with Excel***, BPB Publications, 2019.

Online Resources:

1. https://edu.gcfglobal.org/en/word/
2. https://www.javatpoint.com/ms-word-tutorial

3. https://edu.gcfglobal.org/en/excel/
4. https://www.javatpoint.com/excel-tutorial
5. https://edu.gcfglobal.org/en/powerpoint/
6. https://www.javatpoint.com/powerpoint-tutorial
7. https://www.analyticsvidhya.com/blog/2021/11/a-comprehensive-guide-on-microsoft-excel-for-data-analysis/

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

CO1	Create well formatted word documents using basic word processing features.
CO2	Create professional grade documents and insert external objects in a document.
CO3	Utilize spreadsheets for various data processing tasks with formulas and functions.
CO4	Design and deliver effective presentations for various requirements.
CO5	Explore and use free productivity apps on cloud like forms, docs, and sheets.

Program Outcomes Relevant to the Course:

PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Communicative & Technical English	L-T-P	Credits	Marks
SEC	HS1001		0-0-4	2	100

Objectives	The objective of this laboratory course is to provide practice sessions to enhance the communication ability of the students in the four language skills with special focus on technical communication.
Pre-Requisites	Knowledge of general communication in English is required.
Teaching Scheme	Regular laboratory classes with various tasks designed to facilitate technical communication through pair and/or team activities with regular assessments, presentations, discussions, role-playing, audio-visual supplements, writing activities, business writing practices and vocabulary enhancement.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to the course and diagnostic test.
2	JAM: content development, structuring and delivery.
3	Group presentation.
4	Effective Verbal Communication exercises: plain English, bias-free language, formal and informal style, usage etc.
5	Activities on non-verbal communication.
6	Sounds of English: Vowels and consonants.
7	Sounds of English: Transcription.
8	Sounds of English: Syllable and stress.
9	Sounds of English: Rhythm.
10	Sounds of English: Intonation I.
11	Sounds of English: Intonation II.
12	Role play on simulated business contexts considering different channels of business communication.
13	Listening comprehension.
14	Practice on elements of business writing.
15	Composing effective paragraphs with unity, coherence, cohesion, progression.
16	Process writing.
17	Writing memos.
18	Emails and email etiquette.
19	Business letter I.
20	Business letter II.
21	Error correction: usage and grammar.
22	Reading Comprehension I: Essay – skimming, scanning, inferential comprehension, critical reading.

Cont'd. . .

Experiment-#	Assignment/Experiment
23	Reading Comprehension II: Short story – Analysing the tone of the author.
24	Reading Comprehension III: News editorial – Differentiating facts from opinion.
25	Reading Comprehension IV: Texts on Science and Technology – Identifying discourse markers.
26	Reading Comprehension V: Texts on Science and Technology – Intensive reading and note-taking.
27	Note-making and summary writing.
28	Verbal Advantage: Vocabulary exercises.

Text Books:

T1. M. A. Rizvi, ***Effective Technical Communication***, 2nd Edition, Tata McGraw Hill, 2017.
T2. M. Raman and S. Sharma, ***Technical Communication: Principles and Practices***, Oxford University Press.
T3. B. K. Das, K. Samantray, R. Nayak, S. Pani, and S. Mohaty, ***An Introduction to Professional English & Soft Skills***, Cambridge Univ. Press, 2009.

Reference Books:

R1. J. Seeley, ***The Oxford Guide to Effective Writing and Speaking: How to Communicate Clearly***, 3rd *Ed.*, Oxford University Press, 2013.
R2. S. Kumar and P. Lata, ***Communication Skils***, Oxford University Press, 2011.
R3. T. Panigrahi, ***Communicative Competence***, 1st *Ed.*, Notion Press, 2024.

Online Resources:

1. https://nptel.ac.in/courses/109/106/109106094/: by Prof. A. Iqbal, IIT Madras
2. https://nptel.ac.in/courses/109/104/109104031/: by Dr. T. Ravichandran, IIT Kanpur
3. https://ocw.mit.edu/courses/comparative-media-studies-writing/21w-732-5-introduction-to-technical-communication-explorations-in-scientific-and-technical-writing-fall-2006/download-course-materials/

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

CO1	Communicate with clarity, fluency and impact.
CO2	Develop comprehensive understanding of communication concepts, its importance, types, barriers and principles.
CO3	Communicate effectively in business set-ups.
CO4	Compose coherent, clear and impactful business correspondences.
CO5	Practice sub-skills of reading and become adept readers.

Program Outcomes Relevant to the Course:

PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.

Cont'd. . .

PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Linear Algebra & Numerical Methods	L-T-P	Credits	Marks
UCR	MT1003		3-0-0	3	100

Objectives	The objective of this course is to familiarize the students with the Linear Algebra and various computational methods to handle Linear Systems, large-scale Matrices and Interpolations.
Pre-Requisites	Basic concepts of system of Linear Equations and Matrix Algebra, Coordinate Geometry and Elementary Calculus.
Teaching Scheme	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

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Geometry of Linear Equations, Gaussian Elimination, Vector Space & Subspaces, Solving a Linear System, Linear Independence, Basis and Dimension, The Four Fundamental Subspaces, Linear Transformation, Orthogonal Vectors, Projections to a line, Projections and Least Squares, Orthogonal Bases and Gram-Schmidt.	**10 Hours**
Module-2	Eigen Values and Eigen Vectors, Diagonalization of a Matrix, Complex Matrices, Similarity Transformation, Test for Positive Definiteness, Singular Value Decomposition.	**8 Hours**
Module-3	Error Analysis, Solution of Non-Linear Equations, Bisection Method, Fixed Point Iteration Method, Secant Method and Newton Method.	**8 Hours**
Module-4	Interpolation by Polynomials, Lagrange Interpolation, Newton Divided Differences, Newton's forward & backward Interpolation, Cubic Spline Interpolation; Numerical Integration, Trapezoidal and Simpson's Rules, Composite Rules, Error Formulae and Gaussian Quadrature Rules.	**8 Hours**
Module-5	Linear System of Equations, LU Decomposition, Jacobi and Gauss-Seidel Methods, Eigen Value Problems – Power Method and Inverse Power Method.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. G. Strang, ***Linear Algebra and Its Applications***, 4th *Ed.*, Cengage Learning, 2015.
T2. M. K. Jain, S. R. K. Iyengar, and R. K. Jain, ***Numerical Methods for Scientific and Engineering Computation***, 3rd *Ed.*, New Age International Publishers, 2020.

Reference Books:

R1. E. Kreyszig, ***Advanced Engineering Mathematics***, 8th *Ed.*, Wiley India, 2015.

Online Resources:

1. https://nptel.ac.in/courses/111108066/: by Prof. V. Rao, IISc Bangalore
2. https://nptel.ac.in/courses/117103064/: by Prof. R. Usha, IIT Madras

P.T.O

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

CO1	Solve an inconsistent linear system by least square approximation.
CO2	Factorize a matrix using different methods for computational applications.
CO3	Solve a transcendental equation by numerical methods.
CO4	Interpolate a data set using appropriate mathematical technique.
CO5	Apply appropriate numerical methods to solve linear systems and Eigen value problems.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.

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

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

Category	Code	Biology for Computer Applications	L-T-P	Credits	Marks
UCR	BL1001		3-0-0	3	100

Objectives	The objective of this course is to introduce the basic concepts of modern biology to allow computer professionals analyze problems from both an engineering and biological perspectives, anticipate specific issues in working with living systems, and formulate possible solutions through application of computers.
Pre-Requisites	Basic knowledge of biology, chemistry, and physics is adequate.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with real-world examples and applications.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Physical and chemical principles involved in maintaining life processes; Cell Structure & Functions (Prokaryotic and Eukaryotic cells), Structure and functions of cellular components, Cell wall, Plasma membrane, Endoplasmic reticulum; Tissue systems – Overview of animal and plant tissue systems, Cell cycle & cell division.	**8 Hours**
Module-2	**Biomolecules**: Structure and function of carbohydrates, Lipids, Amino acids, Proteins, and Nucleic acids; Metabolism – Enzymes, Catalysis mechanisms, The spontaneity of biochemical reactions, ATP as an energy currency, Concept of energy charge, Aerobic respiration, Gluconeogenesis.	**9 Hours**
Module-3	**Genetics**: Laws of heredity (Mendelian and Non-Mendelian), Mutations – Cause, types, and effects on species, Generic basis of diseases, Origin of Life – Haldane and Oparin's concepts; Evolution – Modern concept of natural selection and speciation, Lamarckism, Darwinism & Neo-Darwinism.	**8 Hours**
Module-4	**Microorganisms & Human Health**: Concept of single-celled organisms, Concept of species and strains, Ecological aspects of single-celled organisms, Microbial diseases, Epidemiology, and Public Health; Human immune mechanism, Types of immunity, Antigen & Antibody reactions, Immunological disorders, Auto-immune diseases, Immunological databases and tools.	**9 Hours**
Module-5	**Biotechnology**: Basic concepts on Totipotency and Cell manipulation, Recombinant DNA technology and its application in Agriculture, Medicine, and Health; Bioinformatics – Introduction, Software, and Tools of Bioinformatics.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. Wiley Editorial, ***Biology for Engineers***, John Wiley & Sons, 2018.
T2. S. Singh, T. Allen, ***Biology for Engineers***, 1st *Ed.*, Vayu Education of India, 2014.
T3. A. D. Baxevanis and B. F. F. Ouellette, ***Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins***, 2nd *Ed.*, Wiley India, 2004.
T4. U. Satyanarayana, ***Biotechnology***, 12th *Ed.*, Books and Allied. 2019.

Reference Books:

R1. A. T. Johnson, ***Biology for Engineers***, 1st *Ed.*, CRC Press, 2010.
R2. C. D. Tamparo and M. A. Lewis, ***Diseases of the Human Body***, 6th *Ed.*, F. A. Davis Co., 2016.
R3. N. A. Campbell, L. A. Urry, M. L. Cain, S. A. Wasserman, P. V. Minorsky, and J. B. Reece, ***Biology: A Global Approach***, 10th *Ed.*, Pearson Education, 2014.

Online Resources:

1. https://nptel.ac.in/courses/121106008: by Dr. M. Dixit and Prof. G.K. Suraishkumar, IIT Madras
2. https://www.genome.gov/genetics-glossary/Bioinformatics

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

CO1	Explain the structure & composition of cells and cellular components.
CO2	Comprehend structure & functions of different types of biomolecules and their interactions.
CO3	Describe basic concepts of genetics and explain hereditary patterns, mutation, and evolution.
CO4	Recognize microbial diseases, defense mechanisms, and immunological databases and tools.
CO5	Explore applications of bioinformatics & biotechnology to solve problems in different domains.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Microprocessors & Microcontrollers	L-T-P	Credits	Marks
PCR	EC1006		3-0-0	3	100

Objectives	The objective of this course is to study different microprocessors and microcontrollers to develop assembly level programs as per user requirements, and interface them with other external devices.
Pre-Requisites	Basic knowledge of digital electronic circuits is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: 8085 microprocessor & its organization, General architecture, Bus organization, Memory concepts, Pins and Signals, Timing diagram, Instruction Set & programming, Addressing modes, Memory interfacing, Interrupts.	**9 Hours**
Module-2	**Intel 8086 Microprocessor**: Bus Interface unit, Execution Unit, Register Organization, Memory Segmentation, Pin architecture, Minimum and Maximum mode, Physical Memory Organization, Memory Interfacing, Interrupts, Addressing Modes, Instructions; Advanced Co-processor Architectures – Intel 80386, Pentium.	**9 Hours**
Module-3	**Interfacing with Peripheral ICs**: System level interfacing design with various ICs like 8255 Programmable Peripheral Interface, 8257 DMA Controller, 8259 Programmable Interrupt Controller, 8251 Programmable Communication Interface.	**8 Hours**
Module-4	**Microcontrollers** : 8051 systems – Introduction, Architecture, Memory Organization, Special Function Register, Port Operation, Memory Interfacing, I/O Interfacing, Serial Data Transfer Scheme, On board Communication Interfaces – I2C Bus, SPI Bus, USART, External Communication Interfaces- RS232, USB.	**8 Hours**
Module-5	**Microcontroller Programming**: 8051 Instruction set, Interrupts, Programming and Applications: Servo motor, Stepper motor control; 8051 Timers and Counters, Serial Communication, I/O Interfacing using 8255, Light Emitting Diodes(LEDs), Push Buttons, Relays and Latch Connections.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. R. S. Gaonkar, ***Microprocessor Architecture, Programming and Applications with the 8085***, 6th *Ed.*, Penram International Publishing, 2013.

T2. A. K. Ray and K. M. Bhurchandani, ***Advanced Microprocessors and Peripherals***, 2nd *Ed.*, McGraw Hill Education, 2006.

T3. M. A. Mazidi, J. G. Mazidi, R. McKinlay, ***The 8051 Microcontroller and Embedded Systems: Using Assembly and C***, 2nd *Ed.*, Pearson Education, 2011.

Reference Books:

R1. K. Kant, ***Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096***, 2nd *Ed.*, Prentice Hall India, 2013.
R2. D. Hall, ***Microprocessors and Interfacing***, 3rd *Ed.*, McGraw-Hill Education, 2017.
R3. K. J. Ayala, ***The 8051 Microcontrollers***, 3rd Edition, Cengage Learning, 2004.

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, modes & memory management.
CO2	Explain the architecture, programming & memory interfacing of 8086 Microprocessor, virtual memory and co-processor architecture in different advanced processors.
CO3	Interface external devices like keyboard & display with the processors as per user requirements.
CO4	Describe the functionality of microcontrollers and program them to perform tasks as per needs.
CO5	Explore microprocessor and microcontroller based systems for real world applications.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Programming - II	L-T-P	Credits	Marks
PCR	CS1008		3-0-0	3	100

Objectives	The objectives of this course is to study problem-solving using advanced concepts of the C programming language like pointers, structures, and file processing.
Pre-Requisites	Knowledge of basic C programming previously completed and analytical, logical, and problem solving skills is required for this course.
Teaching Scheme	Regular classroom lectures with the use of ICT as and when required; sessions are planned to be interactive with problem-solving and programming activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Arrays and Strings**: Review of 1-D and 2-D arrays, Character arrays and strings – Declaration and Initialization, Manipulation, Handling input & output of strings, Operations on strings, Array of strings, Built-in string handling functions in C.	**9 Hours**
Module-2	**User-defined Data Types**: Enumeration (enum) and its use, Structures – Declaration and initialization, Creating structure variables, Size of a structure, Slack bytes, Accessing members of a structure, Copying and comparing structure variables, Nested structures, Array of structure, Arrays within structures, Bit-fields in a structure, taking input for bit-fields, Union, Difference between structure and union, typedef.	**8 Hours**
Module-3	**Pointers in C**: Concepts of pointer, Declaration and initialization of pointer variable, Accessing variable through a pointer, Pointer arithmetic, Pointer expression, Chain of pointers, Using pointer with arrays and strings, Array of pointers, Pointer to an array, Pointer to structure, Accessing structure members through pointer, Self-referential structures, Idea on linked lists.	**8 Hours**
Module-4	**Pointers & Functions**: Parameter passing using call by reference, Passing an array to function, Passing structure to function, Function returning pointer, Pointer to function; Command-line arguments – Passing parameters from the command line, Pre-processor directives, Macros, File inclusion.	**8 Hours**
Module-5	**DMA & File Handling**: Dynamic memory allocation using the malloc(), calloc(), and realloc() functions, Need of type-casting, Releasing memory using free() function; File Handling – Concept of files, text vs binary file, File opening and closing, Standard and formatted input/output operation on text files, Random access on files using ftell(), fseek(), and rewind() functions, Binary data reading & writing using fread() and fwrite() functions.	**9 Hours**
	Total	**42 Hours**

Text Books:

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

P.T.O

Reference Books:

R1. R. Thareja, ***Programming in C***, 2nd *Ed.*, Oxford University Press, 2006.
R2. B. W. Kernighan and D. M. Ritchie, ***The C Programming Language***, 2nd *Ed.*, Pearson Education, 2015.
R3. H. Schildt, ***C: The Complete Reference***, 4th *Ed.*, McGraw-Hill, 2017.
R4. B. Gottfried, ***Schaum's Outline of Programming with C***, 3rd *Ed.*, McGraw-Hill, 2017.

Online Resources:

1. https://nptel.ac.in/courses/106105171/: by Prof. A. Basu, IIT Kharagpur
2. https://nptel.ac.in/courses/106102066/: by Prof. S. A. Kumar, IIT Delhi
3. https://nptel.ac.in/courses/106104074/: by Prof. D. Gupta, IIT Kanpur
4. https://www.cs.uic.edu/~jbell/CourseNotes/C_Programming/
5. http://www.stat.cmu.edu/~hseltman/c/CTips.html
6. https://www.learn-c.org/
7. https://c-faq.com/

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

CO1	Perform various operations on character arrays and strings in C programs.
CO2	Create user-defined data types to handle heterogeneous data items.
CO3	Write efficient C programs using the concepts of pointers in multiple ways.
CO4	Develop programs using command-line arguments, pre-processor directives, and macros.
CO5	Apply run-time memory management and develop C programs to create and manipulate files.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Web Design with HTML & CSS	L-T-P	Credits	Marks
PCR	CS1009		3-0-0	3	100

Objectives	The objectives of this course is to learn designing and creating static web pages using HTML, styling them using CSS, and creating responsive layouts to make attractive websites that are accessible from various devices.
Pre-Requisites	Basic computer skills and idea of internet and websites is adequate for this course.
Teaching Scheme	Regular classroom lectures with the use of ICT as and when required; sessions are planned to be interactive with focus on designing and programming activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: History of Internet, TCP/IP, IP Address - IPv4 & IPv6, DNS, Structure of URL, World Wide Web, Web page, Website, Web server, Web browser, MIME types, Web hosting, Client-server Model, The HTTP Request-Response Model, Request & response headers, Response codes, Structure of a website, Planning & designing a website, Static vs. dynamic websites.	**7 Hours**
Module-2	**HTML**: Structure of a web page, HTML tags, attributes, and elements, Basic HTML tags, Text formatting, HTML entities, Fonts & colors, Lists & nested lists, Hyperlinks, Bookmarks, Tables, merging of cells, nested tables, Images & image maps, Forms & form elements, Boolean attributes.	**10 Hours**
Module-3	**Audio & Video**: Embedding audio and video content, attributes, and MIME types, Embedding external content using iframe, Embedding multimedia content (YouTube videos, Google Maps, etc.); The div & span tags, Semantic tags - header, footer, section, article, aside, nav; Metadata & SEO: The meta tag, Character set, Keywords, Description, Author, Viewport.	**8 Hours**
Module-4	**CSS**: Overview of CSS, Inline, internal, and external CSS, Syntax of CSS rules, Selectors, Order and specificity, Style properties, Fonts, Colors, Alignment, CSS Box Model - margin, border, padding, and content, Positioning elements - static, relative, absolute, and fixed, Styling tables and forms, Background colors and images, Adding shadow and gradients, CSS tips & tricks.	**9 Hours**
Module-5	**Responsive Layout**: Flex containers and flex items, Responsive layouts with Flexbox, Grid layout - container, rows, columns and items, Transitions & animations - Introduction, Transitioning properties, Creating keyframe animations, Adding animation delays & timing functions, Responsive web design - viewport and breakpoints, Syntax & usage of media queries, Creating responsive layouts for different screen sizes, Introduction to CSS frameworks.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. T. A. Powell, ***HTML & CSS: The Complete Reference***, 5th *Ed.*, McGraw-Hill Education, 2017.
T2. J. Duckett, ***HTML & CSS: Design and Build Webs***, 1st *Ed.*, Wiley India, 2011.

Reference Books:

R1. B. Frain, T. Firdaus, and B. LaGrone, ***HTML5 and CSS3: Building Responsive Websites***, 1st *Ed.*, Packt Publishing, 2016.
R2. P. Kumar, ***Web Design With HTML & CSS : HTML & CSS Complete Beginner's Guide***, 1st *Ed.*, Notion Press, 2021.

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105084/: by Prof. I. Sengupta, IIT Kharagpur
2. https://www.w3schools.com/html/
3. https://www.w3schools.com/css/

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

CO1	Explain the basics and working of Internet and the World Wide Web.
CO2	Develop structured web pages using HTML, display data and collect user data through forms.
CO3	Create multimedia enriched web pages, understand semantic elements and use of metadata.
CO4	Design visually appealing websites using the power of CSS and test for browser compatibility.
CO5	Develop responsive websites accessible from various devices and explore advanced frameworks.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Microprocessors & Microcontrollers Lab	L-T-P	Credits	Marks
PCR	CS1010		0-0-2	1	100

Objectives	The objective of the course is to provide hands-on practice on programming of microprocessors and microcontrollers and their interfacing with external devices.
Pre-Requisites	Basic analytical skills including basic knowledge of digital electronics is required.
Teaching Scheme	Regular laboratory experiments to be conducted under the supervision of the teacher; the experiments shall consist of programming assignments.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Program for arithmetic operations using 8085.
2	Program for finding the largest and smallest from a set of numbers using 8085.
3	Program for arranging numbers in ascending and descending order using 8085.
4	Programs for 16 bit arithmetic operations using 8086.
5	Programs for Sorting and Searching (using 8086).
6	Programs for String manipulation operations (using 8086).
7	Interfacing ADC and DAC.
8	Parallel Communication between two MP Kits using Mode-1 and Mode-2 of 8255.
9	Programming using Arithmetic, Logical and Bit Manipulation instructions of 8051 microcontroller.
10	Programming and verifying Timer, Interrupts and UART operations in 8051 microcontroller.
11	Interfacing and Programming of Stepper Motor and DC Motor Speed control.
12	Programming and verifying Timer, Interrupts and UART operations in 8051 microcontroller.
13	Communication between 8051 Microcontroller kit and PC.
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***, 6th *Ed.*, Penram International Publishing, 2013.

T2. A. K. Ray and K. M. Bhurchandani, ***Advanced Microprocessors and Peripherals***, 2nd *Ed.*, McGraw Hill Education, 2006.

T3. M. A. Mazidi, J. G. Mazidi, R. McKinlay, ***The 8051 Microcontroller and Embedded Systems: Using Assembly and C***, 2nd *Ed.*, Pearson Education, 2011.

Reference Books:

R1. K. Kant, ***Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096***, 2nd *Ed.*, Prentice Hall India, 2013.

R2. D. Hall, ***Microprocessors and Interfacing***, 3rd *Ed.*, McGraw-Hill Education, 2017.

R3. K. J. Ayala, ***The 8051 Microcontrollers***, 3rd Edition, Cengage Learning, 2004.

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

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

CO1	Describe the assembly language programming & instruction sets of 8086 microprocessor.
CO2	Write assembly language programs using various arithmetic, logical, and string operations.
CO3	Develop assembly level programs for finding largest/smallest numbers, existence of data, etc.
CO4	Explore assembly level programming of 8051 microcontroller & its applications in real world.
CO5	Interface microprocessors and microcontrollers with external peripheral devices.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Programming - II Lab	L-T-P	Credits	Marks
PCR	CS1011		0-0-2	1	100

Objectives	The objectives of this course is to provide hands-on practice on programming and problem-solving using advanced features of the C programming language like pointers, structures, command-line arguments, and file processing.
Pre-Requisites	Knowledge of basic C programming and topics taught in the class is required.
Teaching Scheme	Regular laboratory classes are conducted under the supervision of the teacher. The experiments shall comprise of programming assignments.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Programs on input/output of strings and simple operations on strings.
2	Programs on strings using built-in string handling functions.
3	Programs on creating and using simple and nested structures.
4	Programs on bit-fields, array of structures, union, and enum.
5	Programs on use of pointers with variables of different data-types.
6	Programs on array operations using pointers.
7	Programs on string manipulation using pointers.
8	Programs on pointers to structures.
9	Programs on functions using call by reference.
10	Programs on passing arrays (1D and 2D) and structures to functions.
11	Programs on designing user-defined functions for string manipulation.
12	Programs on command-line arguments, pre-processor directives, and macros.
13	Programs on various operations on text files.
14	Programs on various operations on binary files.

Text Books:

T1. E. Balagurusamy, ***Programming in ANSI C***, 7th *Ed.*, McGraw-Hill Education, 2017.
T2. M. Sprankle and J. Hubbard, ***Problem Solving and Programming Concepts***, 9th *Ed.*, Pearson Education, 2011.

Reference Books:

R1. B. W. Kernighan and D. M. Ritchie, ***The C Programming Language***, 2nd *Ed.*, PHI, 2012.
R2. H. M. Deitel and P. J. Deitel, ***C How to Program***, 3rd *Ed.*, Pearson Education Asia,2001.
R3. H. Schildt, ***C: The Complete Reference***, 4th *Ed.*, McGraw-Hill Education, 2017.

Online Resources:

1. https://nptel.ac.in/courses/106105171/: by Prof. A. Basu, IIT Kharagpur
2. https://nptel.ac.in/courses/106102066/: by Prof. S. A. Kumar, IIT Delhi
3. https://nptel.ac.in/courses/106104074/: by Prof. D. Gupta, IIT Kanpur
4. https://www.cs.uic.edu/~jbell/CourseNotes/C_Programming/
5. http://www.stat.cmu.edu/~hseltman/c/CTips.html

6. https://www.learn-c.org/
7. https://c-faq.com/

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

CO1	Develop C programs for manipulation of character arrays and strings.
CO2	Manipulate heterogeneous data items using structure, bit-fields, and union.
CO3	Develop efficient C programs using pointers and call by reference.
CO4	Construct C programs using command line arguments, pre-processor directives, and macros.
CO5	Manage memory at run-time as required and manipulate data stored in text or binary files.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Web Design with HTML & CSS Lab	L-T-P	Credits	Marks
PCR	CS1012		0-0-2	1	100

Objectives	The objective of this laboratory course is to provide hands-on exercises on designing attractive and multimedia enriched semantic web pages using HTML and CSS including creating user-friendly responsive layouts.
Pre-Requisites	Familiarity with internet browsing and basic skills on text editors is required.
Teaching Scheme	Regular laboratory classes are conducted under the supervision of the teacher. The experiments shall comprise of coding assignments.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Find out IP Address, DNS query, Capture HTTP Request & Response.
2	Create a basic HTML web page with headings, paragraphs, and images.
3	Navigation using hyperlinks and bookmarks.
4	Create different types of lists and nested lists.
5	Design forms with different input types and form elements.
6	Utilize semantic HTML elements and meta data.
7	Create an image gallery application with iframe.
8	Embed audio, video, and other external resources on a web page.
9	Style text content using basic CSS properties for font, color, and alignment.
10	Use of CSS selectors to target specific elements on a web page.
11	Apply CSS box model properties to create spacing and borders around elements.
12	Styling tables and form elements using CSS.
13	Create multi-column layout using CSS flexbox & grid and organize content in cells.
14	Apply CSS transitions to animate changes in element properties.

Text Books:

T1. T. A. Powell, ***HTML & CSS: The Complete Reference***, 5th *Ed.*, McGraw-Hill Education, 2017.
T2. J. Duckett, ***HTML & CSS: Design and Build Webs***, 1st *Ed.*, Wiley India, 2011.

Reference Books:

R1. B. Frain, T. Firdaus, and B. LaGrone, ***HTML5 and CSS3: Building Responsive Websites***, 1st *Ed.*, Packt Publishing, 2016.
R2. P. Kumar, ***Web Design With HTML & CSS : HTML & CSS Complete Beginner's Guide***, 1st *Ed.*, Notion Press, 2021.

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105084/: by Prof. I. Sengupta, IIT Kharagpur
2. https://www.w3schools.com/html/
3. https://www.w3schools.com/css/

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

CO1	Develop structured & semantically meaningful web pages using HTML.
CO2	Display data on the website in an organized manner and design forms to collect user data.
CO3	Create multimedia enriched web pages, understand semantic elements and use of metadata.
CO4	Design visually appealing websites using the power of CSS and test for browser compatibility.
CO5	Develop a responsive website from a given design using appropriate tools and frameworks.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Corporate Communication Skills	L-T-P	Credits	Marks
SEC	HS1002		0-0-4	2	100

Objectives	The objective of this laboratory course is to give students adequate practice in a simulated professional environment with focus on communication skills with professionalism in a typical corporate set up.
Pre-Requisites	Knowledge of communicative and technical English is required.
Teaching Scheme	Regular laboratory classes with various tasks designed to facilitate communication and soft skills through pair and/or team activities with regular assessments, presentations, discussions, role-playing, audio-visual supplements, writing activities, business writing practices and vocabulary enhancement.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Aspects of Inter-cultural communication and cultural conditioning.
2	Barriers to cross-cultural communication.
3	Personality test and personality development.
4	Team work and its stages.
5	Team work and leadership: Simulation.
6	Negotiation skills: Role-play.
7	Persuasive presentation I.
8	Persuasive presentation II.
9	Writing a blog.
10	Vlog making and presentation I.
11	Vlog making and presentation II.
12	Emotional Intelligence: its importance in the workplace.
13	Time management.
14	Social media etiquette.
15	Business etiquette.
16	Assertiveness at work: Role-play.
17	Power point presentation I.
18	Power point presentation II.
19	Power point presentation III.
20	Power point presentation IV.
21	Mind mapping.
22	Creative and critical thinking for problem solving.
23	Six thinking hats: Problem solving and decision making in meetings.
24	Verbal Ability I: synonyms and antonyms.

Cont'd. . .

Experiment-#	Assignment/Experiment
25	Verbal Ability II: One word substitution.
26	Verbal Ability III: Error correction.
27	Verbal Ability IV: Odd one out.
28	Verbal Ability V: Analogy.

Text Books:

T1. S. B. Bachu, ***Corporate Communication Skills for Professionals***, 1st *Ed.*, White Falcon Publishing, 2021.
T2. M. A. Rizvi, ***Effective Technical Communication***, 2nd *Ed.*, Tata McGraw-Hill, 2017.
T3. M. Raman and S. Sharma, ***Technical Communication: Principles and Practice***, 3rd *Ed.*, Oxford University Press, 2015.

Reference Books:

R1. P. A. Argenti and J. Forman, ***The Power of Corporate Communication: Crafting the Voice and Image of Your Business***, 1st *Ed.*, Tata McGraw-Hill, 2003.
R2. J. Seely, ***The Oxford Guide to Writing and Speaking***, 3rd *Ed.*, Oxford University Press, 2013.
R3. B. K. Mitra, ***Effective Technical Communication - A Guide for Scientists and Engineers***, 1st *Ed.*, Oxford University Press, 2006.

Online Resources:

1. https://archive.nptel.ac.in/courses/109/105/109105144/: by Prof. S. Singh, IIT Kharagpur
2. https://archive.nptel.ac.in/courses/109/106/109106129/: by Dr. Ay. I. Viswamohan, IIT Madras
3. https://archive.nptel.ac.in/courses/109/104/109104030/: by Dr. T. Ravichandran, IIT Kanpur
4. https://www.ef.com/wwen/english-resources/
5. https://owl.purdue.edu/owl/purdue_owl.html
6. https://www.usingenglish.com/
7. http://www.english-test.net

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

CO1	Understand aspects of communication at the workplace and check the barriers.
CO2	Hone persuasive communication skills.
CO3	Enhance interpersonal communication at the corporate workplace.
CO4	Make impactful group/solo presentations and communicate with clarity.
CO5	Enhance verbal ability for better communication.

Program Outcomes Relevant to the Course:

PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Discrete Mathematics	L-T-P	Credits	Marks
PCR	MT2005		3-1-0	4	100

Objectives	The objective of this course is to obtain mathematical maturity on logical & abstract processes, discrete structures including graphs which are essential for students in various computer applications.
Pre-Requisites	Knowledge of Sets, basics of number systems, and matrix algebra is required.
Teaching Scheme	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

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Proof Strategies.	**12 Hours**
Module-2	Mathematical induction, basics of counting, Pigeonhole principle, Generalized permutation and combinations; Recurrence Relations, solving linear Recurrence Relations, Generating functions, Inclusion and Exclusion with applications.	**11 Hours**
Module-3	Relations and their properties, N-ary Relations & their applications, representing relations, Closure of relations, Equivalence relations, partial ordering and Lattice.	**11 Hours**
Module-4	Introduction to Graphs, Graph terminology, Representation of graphs & graph isomorphism, Connectivity, Euler & Hamilton paths, Planar graph & Graph colouring; Trees, Spanning trees.	**12 Hours**
Module-5	Semigroup, Monoid, Groups, Subgroups, Cosets and Lagrange's theorem, Codes and group codes, Rings, Integral Domains & Fields.	**10 Hours**
	Total	**56 Hours**

Text Books:

T1. K. H. Rosen, ***Discrete Mathematics and Its Applications***, 6th *Ed.*, Tata McGraw-Hill, 2008.
T2. C. L. Liu, ***Elements of Discrete Mathematics***, 2nd *Ed.*, Tata McGraw-Hill, 2008.

Reference Books:

R1. J. P. Tremblay and R. Manohar, ***Discrete Mathematical Structures with Applications to Computer Science***, 1st *Ed.*, McGraw-Hill Education, 2017.
R2. J. R. Mott, A. Kandel, and T. P. Baker, ***Discrete Mathematics for Computer Scientists and Mathematicians***, 2nd *Ed.*, Pearson Education, 2015.

Online Resources:

1. https://nptel.ac.in/courses/106104573: by Prof. N. Saxena, IIT Kanpur
2. https://nptel.ac.in/courses/106106183: by Dr. A. Shukla and Prof. S. Iyengar, IIT Ropar
3. https://nptel.ac.in/courses/106108227: by Prof. A. Choudhury, IIIT Bangalore
4. https://nptel.ac.in/courses/106103205: by Prof. B. George and Prof. S. Gopalan, IIT Guwahati

P.T.O

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

CO1	Apply logic for logical inferences in real life problems.
CO2	Apply principle of inclusion & exclusion, generating functions and recurrence relations to solve counting problems.
CO3	Understand and apply the concepts of relation and lattice.
CO4	Apply graph theory to real-life problems of computer science & engineering.
CO5	Differentiate the discrete algebraic structures and apply them to study group codes.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Principles of Management	L-T-P	Credits	Marks
UCR	MG2003		3-0-0	3	100

Objectives	The objective of this course is to understand and apply fundamental concepts of management to effectively manage an organization for maximizing efficiency, achieving organizational goals, and ensuring the overall success of the business.
Pre-Requisites	Basic knowledge of operation of any business organization is adequate.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with examples and case studies.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to Management, Meaning, Nature & Significance, Combination of Art & Science, Management as a Profession, Management vs Administration, Levels of Management, Elements of managerial processes, Styles & Roles of Managers in Organizations, Contributions of Taylor and Fayol, Human Relations & Behavioural Schools, Hawthorne Studies.	**9 Hours**
Module-2	Planning - Nature, Process of Planning, Planning and Environmental Uncertainties, Types of Planning, Advantages and Limitations of Planning, Decision Making, Stages in Decision Making.	**8 Hours**
Module-3	Nature & Significance of Organization, Authority & Responsibility Relationships, Span of Control, Process of Delegations, Barriers to Delegation, Centralization & Decentralization, Concept of Line & Staff, Overcoming Line-Staff conflict, Committees, Coordination, Organization Structures, Types, Advantages & Disadvantages.	**8 Hours**
Module-4	Staffing, Motivation & Leadership, Scope of Staffing Functions, Theories of Motivation, Positive and Negative Motivation, Group Motivation, Theory X, Theory Y, Theory Z, Maslow's need hierarchy, Leadership Definition, Meaning, Factors, Theories, Principles and Leadership Styles.	**9 Hours**
Module-5	Communications of Control, Process of Communication, Verbal & Non-Verbal, Barriers to communication, Types, Process, Tools of control, Characteristics of Effective Control System, Human Reaction to control system, Social Responsibility – Meaning, Definition, Features, Scope, Social Responsibility of a Manager, Interested Group – Shareholders, Workers, Customers, Creditors, Suppliers, Government, Society, Indian Business and Social Responsibility.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. P. F. Ducker, ***The Practice of Management***, Harvard Business Press, 2010.
T2. P. F. Ducker, ***Management: Tasks, Responsibilities and Practices***, Harper Collins, 2009.
T3. S. P. Robbins and M. A. Coulter, ***Management***, 15th *Global Ed.*, Pearson, 2020.

Reference Books:

R1. P. Durai, ***Principles Of Management: Text and Cases***, 2nd *Ed.*, Pearson, 2019.
R2. P. Kapoor, ***Principles of Management***, 1st *Ed.*, Khanna Publishing House, 2019.

R3. K. Navarathinam, ***Principles of Management***, 1st *Ed.*, Shanlax Publications, 2015.
R4. L. M. Prasad, ***Principles and Practices of Management***, 1st *Ed.*, S. Chand & Sons, 2020.

Online Resources:

1. https://nptel.ac.in/courses/110107150: by Prof. U. Lenka, IIT Roorkee
2. https://nptel.ac.in/courses/110105146: by Prof. Srinivasan and Mukhopadhyay, IIT Kharagpur
3. https://baou.edu.in/assets/pdf/PGDBA_101_slm.pdf

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

CO1	Describe the importance of principles of management.
CO2	Associate the importance of planning and decision making in an organization.
CO3	Interpret the knowledge of organization and its types.
CO4	Acquire concepts in motivation, leadership and responsibilities as a manager.
CO5	Summarize effective control in the management and practice management functions.

Program Outcomes Relevant to the Course:

PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Data Structures Using C	L-T-P	Credits	Marks
PCR	CS2017		3-1-0	4	100

Objectives	The objective of this course is to understand the abstract data types, solve problems using appropriate data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees and graphs.
Pre-Requisites	Knowledge of programming in C, specifically on structures, pointers, functions, recursion etc., are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with programming and problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction, classification of data structures, algorithms, time and space analysis of algorithms, asymptotic notation, abstract data types, Arrays - introduction, basic operations on array (traverse, insert, delete, search), row and column major representation, sparse matrix representation of sparse matrix using triplet form, operations on sparse matrix (addition, transpose).	**10 Hours**
Module-2	ADT Stack - stack model, representation of stack using array, basic operations with analysis, applications- recursion, and conversion of infix to postfix 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.	**12 Hours**
Module-3	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.	**12 Hours**
Module-4	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.	**12 Hours**
Module-5	Sorting algorithms - bubble sort, selection sort, insertion sort, quick sort, merge sort, radix sort, heap sort; Hashing - hash functions and hashing techniques, collision resolution - linear & quadratic probing, chaining.	**10 Hours**
	Total	**56 Hours**

Text Books:

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

Reference Books:

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

Online Resources:

1. https://nptel.ac.in/courses/106106127: By Prof. H. A. Murthy, et al., IIT Madras
2. https://nptel.ac.in/courses/106102064: By Prof. N. Garg, IIT Delhi
3. https://nptel.ac.in/courses/106106130: By Dr. N. S. Narayanaswamy, IIT Madras
4. https://nptel.ac.in/courses/106106133: By Prof. H. A Murthy, et al., IIT Madras

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

CO1	Compare different programming methodologies and define asymptotic notations to analyze performance of algorithms and get acquainted with array and sparse matrix.
CO2	Apply the basic operations of stacks and queues to solve real world problems.
CO3	Use appropriate data structures like arrays, linked list, stacks and queues to solve real world problems efficiently.
CO4	Represent and manipulate data using nonlinear data structures like trees and graphs to design algorithms for various applications.
CO5	Apply the knowledge of different searching , sorting techniques and various hashing techniques.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Object Oriented Programming in C++	L-T-P	Credits	Marks
PCR	CS2019		3-0-0	3	100

Objectives	The objective of this course is to study the Object Oriented Paradigm and implement the features of OOP using C++ in problem solving.
Pre-Requisites	Knowledge of basic C programming, analytical, logical, and problem-solving skills are required for this course.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with programming and problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction: Overview of Procedural vs. Object-Oriented Programming, OOP concepts: Class, Object, Encapsulation, Inheritance, Polymorphism, Abstraction, Benefits of OOP, Introduction to C++ : Overview, C++ vs. C, Basic C++ syntax, Tokens, Keywords, Data Types, String, Identifiers and Literals, Operators & Expressions in C++, Scope resolution operator, I/O statements, Decision making, Looping.	**9 Hours**
Module-2	Functions: Definition, Prototyping, Recursion, Inline functions, Default & constant arguments; Function overloading; Classes & Objects: Class Declaration, Data members & Member functions, Static members & static member functions, passing object to functions & returning objects, Constructors: Default, Parameterized, Copy constructor, Constructor overloading, Destructors, Access Specifiers, Friend functions.	**9 Hours**
Module-3	Arrays: Array of objects, passing arrays to functions, Arrays as class members; Pointers: Concepts of pointer, Dynamic Memory Allocation and Deallocation, Call by value, Call by reference, pointer to objects, this pointer; Operator overloading, Type conversion, Inheritance: Basics of Inheritance, Types of Inheritance - Single, Multiple, Multilevel, Hierarchical, Hybrid, Ambiguity in multipath inheritance, virtual & pure virtual functions, Abstract Classes, Function overriding, Constructors and Destructors in derived class.	**10 Hours**
Module-4	Exception Handling: Basics of Exception Handling, throw & catch mechanisms, overloading catch block & default catch block; File Handling: Reading & writing into files, File modes, Error handing in files, Binary files and random access to the files.	**7 Hours**
Module-5	Templates: Function Templates, Class Templates, overloading of function template, multiple parameters in function templates, member function templates; Standard Template Library (STL): Components of STL, containers, algorithms, iterators, application of STL.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. E. Balagurusamy, ***Object Oriented Programming with C++***, 8th *Ed.*, McGraw-Hill Education, 2020.
T2. B. Stroustrup, ***The C++ Programming Language***, 4th *Ed.*, Addison-Wesley, 2013.

Reference Books:

R1. R. Lafore, ***Object Oriented Programming with C++***, 4th *Ed.*, SAMS Publishing, 2002.
R2. H. Schildt, ***C++ : The Complete Reference***, 4th *Ed.*, McGraw-Hill Education, 2017.
R3. R. Lischner, ***C++ in a Nutshell***, 1st *Ed.*, O'Reilly Media, 2003.

Online Resources:

1. https://nptel.ac.in/courses/106105151: by P. P. Das, IIT Kharagpur
2. https://nptel.ac.in/courses/106105234: by P. P. Das, IIT Kharagpur
3. https://nptel.ac.in/courses/106101208: by A. G. Ranade, IIT Bombay

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

CO1	Write basic C++ programs using decision making and looping constructs.
CO2	Define classes with data & function members, multiple constructors, and friend functions.
CO3	Implement dynamic memory allocation, inheritance and polymorphism in C++ programs.
CO4	Use exception handling to handle run-time error and files to store & retrive data.
CO5	Apply generic programming using templates & use the standard template library.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Interactive Web Development	L-T-P	Credits	Marks
PCR	CS2021		3-0-0	3	100

Objectives	The objectives of this course are to learn creating dynamic interactive web pages using JavaScript, DHTML, AJAX, and XML technologies.
Pre-Requisites	Knowledge on HTML, CSS, and programming fundamentals is required.
Teaching Scheme	Regular classroom lectures with the use of ICT as and when required; sessions are planned to be interactive with focus on designing and programming activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction: Overview of Web Technologies, Static vs Dynamic Web Pages, DHTML - Components of DHTML (HTML, CSS, DOM, Scripting Languages), Overview of JavaScript and its role in DHTML; Adding JavaScript to HTML, Linked Scripts in HTML, JavaScript Pseudo-URL; Static vs Dynamic Data Type, Differentiating Type Safe and Type Unsafe; Data Types - Basic (Dynamic Typing); Variables: let, const, var; Operators, Expressions, and Statements.	**8 Hours**
Module-2	Data Types: Composite Types (Array and Objects),Fundamentals of Objects, Generic and User-Defined Objects, Array, Boolean, Date, Math, String, and Type-Related Objects, Type Conversion; Functions: Function Basics, Functions as Objects, Recursive Functions; Object-Oriented JavaScript: Constructors, Prototypes, Class Properties, Inheritance via the Prototype Chain, Overriding Properties; Regular Expressions and RegExp Object.	**10 Hours**
Module-3	DOM & Event Handling: The Document Object; Standard Document Object Model, Document Trees, Basic Event Models, DOM Event Model, Animations and Effects, DHTML - DOM and HTML, DOM and CSS, Oriented Object Model; Windows and Frames - Dialogs, Opening and Closing Generic Windows, Controlling Windows, Window Events.	**9 Hours**
Module-4	Building Interactivity: Basic Document Methods, Accessing Specific HTML Element Properties; Form Handling: Basics, Form Fields, Form Validation, Form Usability and JavaScript, Dynamic Forms, DHTML: Images, Rollover Buttons; Navigation: DHTML Menus; Cookies, DOM Storage; AJAX & jQuery.	**8 Hours**
Module-5	XML: Introduction, XML Document, XML Elements, XML Attributes; Well-Formed XML, XML Usage, Valid XML: DTD, Declaring Simple and Compound Element in XML, Occurrences of an Element under Another Element, Elements with any Content, Elements with either-or Content, Declaring Mixed Content, Declaring Attributes for an Element, Displaying XML.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. T. A. Powell and F. Schneider, ***JavaScript: The Complete Reference***, 3rd *Ed.*, McGraw-Hill, 2012.
T2. J. Dean, ***Web Programming with HTML5, CSS, and JavaScript***, 1st *Ed.*, Jones & Bartlett, 2018.
T3. H. Williamson, ***XML: The Complete Reference***, Indian Edition, McGraw-Hill, 2001.

Reference Books:

R1. D. Goodman, ***JavaScript & DHTML Cookbook: Solutions & Examples for Web Programmers***, 1st *Ed.*, O'Reilly Media, 2007.
R2. A. Ranjan, A. Sinha, and R. Battewad, ***JavaScript for Modern Web Development***, BPB Publication, 2020.
R3. E. T. Ray, ***Learning XML***, 2nd *Ed.*, O'Reilly Media, 2003.

Online Resources:

1. https://www.w3schools.com/js/
2. https://www.javatpoint.com/dhtml
3. https://www.geeksforgeeks.org/javascript/
4. https://www.w3schools.com/jquery/default.asp
5. https://www.w3schools.com/xml/

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

CO1	Incorporate client-side scripting using JavaScript in web pages.
CO2	Apply the features of JavaScript for client side scripting.
CO3	Manage events, windows, and manipulate DOM to create interactive web pages.
CO4	Validate forms, manipulate HTML elements, enhance navigation, and interactivity with user.
CO5	Understand XML syntax, implement and validate an XML document using DTD.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Data Structures Using C Lab	L-T-P	Credits	Marks
PCR	CS2018		0-0-4	2	100

Objectives	Develop skills to design and analyze simple linear and nonlinear data structures, strengthening the ability of students to identify and apply the suitable data structure for the given real-world problem.
Pre-Requisites	Knowledge of programming in C, specifically on structures, pointers, functions, recursion are required.
Teaching Scheme	Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise programming assignments.

Evaluation Scheme

Attendance	Daily Performance	Lab Record	Lab Test / 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 the queue using arrays.
11	Operations of a circular queue.
12, 13	Single linked list operations.
14, 15	Double linked list operations.
16	Circular linked list operations.
17	Stack using linked list.
18	Queue using linked list.
19	Polynomial addition using linked-list.
20, 21	Binary Search Tree operations.
22, 23	Graph traversal (BFS, DFS).
24	Warshall's shortest path algorithm.
25, 26	Implementation Insertion Sort and Quicksort.
27, 28	Implementation of Merge Sort and HeapSort.

Text Books:

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

P.T.O

Reference Books:

R1. A. K. Rath and A. K. Jagadev, ***Data Structures Using C***, 2nd *Ed.*, Scitech Publication, 2011.
R2. Y. Kanetkar, ***Data Structures Through C***, 2nd *Ed.*, BPB Publication, 2003.

Online Resources:

1. https://nptel.ac.in/courses/106106127: By Prof. H. A. Murthy, et al., IIT Madras
2. https://nptel.ac.in/courses/106102064: By Prof. N. Garg, IIT Delhi
3. https://nptel.ac.in/courses/106106130: By Dr. N. S. Narayanaswamy, IIT Madras
4. https://nptel.ac.in/courses/106106133: By Prof. H. A Murthy, et al., IIT Madras

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 and Queue. Apply the concept of stack and queue for solving real world problems.
CO3	Implement various operations of single, double and circular linked list and apply them in various applications.
CO4	Construct binary search tree and perform traversal, insertion, deletion, and search operations.
CO5	Perform BFS and DFS traversal in a graph and implement various sorting and searching algorithms.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Object Oriented Programming in C++ Lab	L-T-P	Credits	Marks
PCR	CS2020		0-0-2	1	100

Objectives	The objective of this course is to get a hands on exposure on implementing object oriented concepts and experiment with the features of OOP using the C++ language.
Pre-Requisites	Knowledge of programming in C, specifically on structures, pointers, functions, recursion are required.
Teaching Scheme	Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise programming assignments.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Compilation and execution of simple C++ programs.
2	Programs on data type and variables.
3	Programs using various operators available in C++.
4	Programs on decision making and branching.
5	Programs on loops and nested loops.
6	Programs on function overloading.
7	Programs on classes and objects.
8	Programs on constructors & destructors.
9	Programs on friend functions.
10	Programs on operator overloading.
11, 12	Programs on recursion, static methods.
13, 14	Programs on arrays within object & array of objects.
15, 16	Programs on Pointers to objects, call by reference.
17, 18	Programs on inheritance.
19	Programs on function overriding and virtual functions.
20, 21	Programs on abstract class.
22, 23	Programs on Exception handling.
24, 25	Programs on class templates and function templates.
26, 27	Programs on containers, algorithms, iterators.
28	Programs on file handling.

Text Books:

T1. E. Balagurusamy, ***Object Oriented Programming with C++***, 8th *Ed.*, McGraw-Hill Education, 2020.
T2. B. Stroustrup, ***The C++ Programming Language***, 4th *Ed.*, Addison-Wesley, 2013.

P.T.O

Reference Books:

R1. R. Lafore, ***Object Oriented Programming with C++***, 4th *Ed.*, SAMS Publishing, 2002.
R2. H. Schildt, ***C++ : The Complete Reference***, 4th *Ed.*, McGraw-Hill Education, 2017.
R3. R. Lischner, ***C++ in a Nutshell***, 1st *Ed.*, O'Reilly Media, 2003.

Online Resources:

1. https://nptel.ac.in/courses/106105151: by P. P. Das, IIT Kharagpur
2. https://nptel.ac.in/courses/106105234: by P. P. Das, IIT Kharagpur
3. https://nptel.ac.in/courses/106101208: by A. G. Ranade, IIT Bombay

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

CO1	Write basic C++ programs using decision making and looping constructs.
CO2	Define classes with data & function members, multiple constructors, and friend functions.
CO3	Implement dynamic memory allocation, inheritance and polymorphism in C++ programs.
CO4	Use exception handling to handle run-time error and files to store & retrive data.
CO5	Apply generic programming using templates & use the standard template library.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Interactive Web Development Lab	L-T-P	Credits	Marks
PCR	CS2022		0-0-2	1	100

Objectives	The objective of this laboratory course is to provide hands-on exercise on designing attractive and multimedia enriched semantic web pages using JavaScript, DHTML, and XML including creating user-friendly responsive layouts.
Pre-Requisites	Knowledge on HTML and CSS is required for this course. The experiments shall go along with the topics taught in the theory course.
Teaching Scheme	Regular laboratory classes with the use of ICT whenever required; the experiments shall comprise of designing and programming assignments.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Creating a simple web page by using basic HTML and CSS.
2	Adding JavaScript to HTML (inline, internal, and external scripts), Pseudo-URLs.
3	Programs with variables, static & dynamic data types, operators, expressions.
4	Arrays and objects in JavaScript (Boolean, Date, Math, and String), type conversion.
5	Writing functions in JavaScript, functions as objects, recursive functions.
6	Programming for DHTML (HTML, CSS, DOM, and scripting languages), creating a basic DHTML page.
7	Creating user-defined objects - constructors, prototypes, properties, inheritance, overriding, regular expressions.
8	Event Handling and DOM Manipulation, creating dynamic animations and effects.
9	Form Handling and Validation; display error messages for invalid form inputs.
10	Changing images on hover and dynamic loading of images based on user actions.
11	Creating rollover buttons and dynamic image, implementing navigation menus.
12	Creating XML document, declaring elements, adding attributes, well-formed XML.
13	Validating XML with DTD, declaring element occurrences, and mixed content.
14	Mini Project.

Text Books:

T1. T. A. Powell and F. Schneider, ***JavaScript: The Complete Reference***, 3rd *Ed.*, McGraw-Hill Education, 2012.

T2. J. Dean, ***Web Programming with HTML5, CSS, and JavaScript***, 1st *Ed.*, Jones & Bartlett Learning, 2018.

Reference Books:

R1. D. Goodman, ***JavaScript & DHTML Cookbook: Solutions & Examples for Web Programmers***, 1st *Ed.*, O'Reilly Media, 2007.

R2. A. Ranjan, A. Sinha, and R. Battewad, ***JavaScript for Modern Web Development***, BPB Publication, 2020.

R3. E. T. Ray, ***Learning XML***, 2nd *Ed.*, O'Reilly Media, 2003.

Online Resources:

1. https://www.w3schools.com/js/
2. https://www.javatpoint.com/dhtml
3. https://www.geeksforgeeks.org/javascript/
4. https://www.w3schools.com/xml/

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

CO1	Apply JavaScript for developing interactive web pages along with HTML, CSS and DOM.
CO2	Write programs in JavaScript using object-oriented features and regular expressions.
CO3	Implement event handling, DOM manipulation, animations, and window management.
CO4	Validate forms, manipulate HTML elements, enhance navigation, and implement interactivity.
CO5	Understand, design, implement, and validate XML documents.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Probability & Statistics	L-T-P	Credits	Marks
PCR	MT2006		3-1-0	4	100

Objectives	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.
Pre-Requisites	Basics of Sets, counting techniques, differential and integral calculus of one variable and coordinate geometry of two and three dimensions.
Teaching Scheme	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

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Measures of central tendencies, Elementary probability, Conditional probability, Bayes' Rule (related problems only), Random variable, Binomial & Hypergeometric distribution, Mean and variance.	**11 Hours**
Module-2	The Poisson approximation to Binomial Distribution, Poisson Process, Geometric Distribution & Multinomial Distribution, Continuous random variables, Normal Distribution, Normal Approximation to the Binomial Distribution, Uniform Distribution, Exponential Distribution, Joint Discrete Distribution.	**12 Hours**
Module-3	Populations and Samples, Sampling Distribution of Mean (σ known), Sampling Distribution of Mean (σ unknown) & Sampling Distribution of Variance; Point Estimation of mean, Interval Estimation of mean, Tests of hypotheses and errors involved, Hypotheses concerning one mean, Inference concerning two mean, Estimation of variance, Hypotheses concerning one variance, Hypotheses concerning two variances.	**12 Hours**
Module-4	Estimation of Proportions, Hypotheses Concerning proportion (one & several), Analysis of $r \times c$ table (Contingency table), Goodness of fit.	**10 Hours**
Module-5	The method of least squares, Inferences based on the least square estimation, Curvilinear Regression, Checking the adequacy of the model, Correlation, Analysis of Variance, General principle, Completely Randomized Design, Randomized Block Design.	**11 Hours**
	Total	**56 Hours**

Text Books:

T1. R. A. Johnson, ***Probability and Statistics for Engineers***, 8th *Ed.*, PHI Learning, 2011.

Reference Books:

R1. W. Mendenhall, R. J. Beaver, and B. M. Beaver, ***Probability and Statistics***, 14th *Ed.*, Cengage Learning, 2014.

R2. R. E. Walpole, R. H. Myers, S. L. Myers and K. E. Ye, ***Probability & Statistics for Engineers & Scientists***, PHI Learning, 2012.

Online Resources:

1. https://nptel.ac.in/courses/111105090: by Prof. S. Kumar, IIT Kharagpur
2. https://nptel.ac.in/courses/111102160: by Prof. S. Dhharmaraja, IIT Delhi
3. https://nptel.ac.in/courses/111106415: by Prof. S. Naqvi, IIT Hyderabad
4. https://nptel.ac.in/courses/111104644: by Prof D. Thirumulanathan, IIT Kanpur

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

CO1	Apply the concepts of probability and random variables to evaluate probabilities of events.
CO2	Apply different discrete and continuous probability models to solve real life problems.
CO3	Apply the concepts of sampling to estimate population parameters and test hypothesis.
CO4	Test the goodness of a model and apply it to real life problems.
CO5	Apply regression model and ANOVA to study the characteristics data sets.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Managerial Economics	L-T-P	Credits	Marks
UCR	MG2004		3-0-0	3	100

Objectives	The objective of the course is to learn the concepts of micro-economics along with tools and techniques to enable the students apply them in making a proper business decision as a manager.
Pre-Requisites	Basic knowledge on money matters and simple mathematical aptitude is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with focus on real-world examples and problem solving.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction: Definition, Nature and scope of Managerial Economics & application of Managerial Economics in Decision making Fundamental Economics Concepts; Theory of Consumption-I: Demand, Law of demand, Demand functions, Demand forecasting and its methods & uses, Elasticity of demand, Theory of supply, Market demand and supply functions and curves, Market equilibrium.	**9 Hours**
Module-2	Theory of Consumption-II: Indifference Curve analysis, The Price line or Budget Line, Consumer's equilibrium, Income effect, Income consumption curve, Substitution effect, Price effect, Breaking of price effect into income effect and substitution effect, Application of indifference curves in Giffen goods, Wages & labour supply.	**8 Hours**
Module-3	Production Function & Cost Analysis: Short-run & Long-run production function, Laws of variable proportions & diminishing returns to a factor, Returns to scale, Economies & diseconomies of scale, Estimation of production function - Cobb Douglas production function, Cost analysis, Concepts of economic & accounting cost, Short-run & long-run cost function and curves, Opportunity cost, Concept of revenue.	**8 Hours**
Module-4	Theory of Product Pricing: Objectives of firms, Profit maximization & sales maximization, Market forms - Perfect competition, Price determination under perfect competition, Firm's equilibrium under perfect competition, Monopoly, Monopolistic competition, Oligopoly and Duopoly, Mark-up pricing, Break even analysis.	**9 Hours**
Module-5	National Income and Business Cycles: Definition, Concepts of national income, Measuring the national income in India, Importance of national income analysis, National income and economic welfare; Business Cycles – Meaning, Phases, Types, Characteristics, Causes, Control measures.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. D. N. Dwivedi, ***Managerial Economics***, 7th *Ed.*, Vikas Publishing House, 2009.
T2. D. M. Mithani, ***Managerial Economics: Theory & Applications***, 8th *Ed.*, Himalaya Publishing House, 2017.

T3. D. Salvator and S. K. Rastogi, ***Managerial Economics: Principles and Worldwide Applications***, 9th *Ed.*, Oxford University Press, 2020.

Reference Books:

R1. C. H. Peterson, W. C. Lewis, and S. K. Jain, ***Managerial Economics***, 4th *Ed.*, Pearson Education, 2008.
R2. Geethika, P. Ghosh, P. R. Chaudhary, ***Managerial Economics***, 3rd *Ed.*, McGraw-Hill Education, 2008.
R3. A. Koutsoyiannis, ***Modern MicroEconomics***, 2nd *Ed.*, Palgrave Macmillan, 2003.

Online Resources:

1. https://nptel.ac.in/courses/110101149: by Prof. T. Mishra, IIT Bombay
2. https://ddceutkal.ac.in/Syllabus/MCOM/Managerial_Economics.pdf

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

CO1	Describe the principles of managerial economics and demand vs. supply.
CO2	Explain the theory of consumption through indifference curve analysis.
CO3	Apply the concept of production functions and perform cost analysis.
CO4	Recognize market structures and apply methods for profit maximization.
CO5	Describe the concept of national income and nature of business cycles.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Java Programming	L-T-P	Credits	Marks
PCR	CS2023		3-1-0	4	100

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

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Java Overview, Java Virtual Machine (JVM), Data types, Operators, Conditionals, Control statements, Arrays, Class fundamentals; Object Oriented Concepts: Object oriented systems development life-cycle, Java buzzwords, Objects, Methods, Constructors, Overloading.	**12 Hours**
Module-2	**Inheritance**: Basics of Inheritance, Types, Using super and final keyword, Method overriding, Abstract classes, Defining and importing packages, Access specifiers, Interface.	**10 Hours**
Module-3	**Exception handling**: Exception fundamentals, types, understanding different keywords (try, catch, finally, throw, throws), User defined exception handling; Threads: thread model, use of Thread class and Runnable interface, thread synchronization, multithreading, inter thread communication.	**12 Hours**
Module-4	**Input/Output**: Files, Stream classes, Reading console input; String manipulation: Basics of string handling, String class, StringBuilder, StringBuffer, String Tokenizer.	**10 Hours**
Module-5	**GUI Programming**: Working with windows, Frames, Graphics, Color, and Font; Swing fundamentals; Event handling: Delegation event model, Event classes, Sources, Listeners; Introduction to Collection framework.	**12 Hours**
	Total	**56 Hours**

Text Books:

T1. J. Keogh, ***J2EE: The Complete Reference***, 11th *Ed.*, McGraw-Hill Education, 2017.
T2. Y. D. Liang, ***Introduction to Java Programming***, 9th *Ed.*, Pearson Education, 2012.

Reference Books:

R1. B. Bates and K. Sierra, ***Head First Java***, 2nd *Ed.*, O'Reilly Media, 2005.
R2. R. N. Rao, ***Core Java: An Integrated Approach***, 5th *Ed.*, DreamTech Press, 2016.
R3. T. Budd, ***An Introduction to Object-Oriented Programming***, 3rd *Ed.*, Pearson Education, 2009.
R4. I. Horton, ***Beginning Java***, 7th *Ed.*, Wrox Publications, 2011.

Online Resources:

1. https://nptel.ac.in/courses/106105191: Prof. D. Samanta, IIT Kharagpur
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/6-092-introduction-to-programming-in-java-january-iap-2010/

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

CO1	Apply object-oriented principles to develop Java programs for real life applications.
CO2	Employ inheritance techniques for developing reusable software.
CO3	Develop robust & concurrent programs using exception handling and multi-threading.
CO4	Design programs using I/O operations, and use string classes.
CO5	Design user-friendly GUI applications using Java Swing.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Design & Analysis of Algorithms	L-T-P	Credits	Marks
PCR	CS2002		3-1-0	4	100

Objectives	The objective of this course is to study the classic algorithms in various domains, techniques for designing efficient algorithms, apply algorithm design techniques to solve complex problems, and analyze the complexities of the solutions.
Pre-Requisites	Knowledge of Discrete Mathematics and Data Structures is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving & analysis.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction, Definition, Characteristics of algorithms, Growth of functions, Asymptotic analysis, Standard notations and common functions, Recurrences, Solution of recurrences by iterative, Substitution, Recursion tree and Master method; Algorithm design techniques, Divide and conquer strategy: Merge Sort, Quick Sort.	**12 Hours**
Module-2	Heaps, Types of Heap, Maintaining the heap property, Building a Heap,The Heap-sort algorithm, Priority Queue; Dynamic Programming: Matrix chain multiplication, Longest Common Subsequence, Assembly-Line Scheduling, Travelling Salesman Problem.	**11 Hours**
Module-3	Greedy Algorithms: Activity selection problem, Fractional Knapsack problem, Huffman codes; Branch & Bound techniques: Travelling Salesman Problem, 0-1 Knapsack Problem; Backtracking: N-Queens Problem, Graph Coloring Problem; Data structure for disjoint sets, Disjoint set operations.	**11 Hours**
Module-4	Graph Traversal Algorithms: Breadth-first and Depth-first search; Minimum spanning trees: Kruskal and Prim's algorithms; Single source shortest path algorithms: Bellman-Ford, Dijkstra, All-pair shortest path algorithm: Floyd-Warshall; Transitive closure of a directed graph; Maximum flow problem: Ford-Fulkerson algorithm.	**12 Hours**
Module-5	String Matching Algorithms: Naive, Rabin-Karp, Knuth-Morris-Pratt algorithm; NP Completeness: Basic Concepts, non-deterministic algorithm; Polynomial time reduction, Computability classes: P, NP, NP complete, NP hard; Satisfiability Problem (3 CNF SAT), Cook's theorem (without proof); Standard NP complete problems: Clique decision problem, Vertex cover and Chromatic number decision problems; Approximation algorithm characteristics.	**10 Hours**
	Total	**56 Hours**

Text Books:

T1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, ***Introduction to Algorithms***, 3rd *Ed.*, PHI Learning, 2014.

T2. E. Horowitz, S. Sahni, and S. Rajasekaran, ***Fundamentals of Computer Algorithms***, 2nd *Ed.*, University Press, 2015.

T3. J. Kleinberg and É. Tardos, ***Algorithm Design***, 1st *Ed.*, Pearson Education, 2013.

Reference Books:

R1. M. T. Goodrich and R. Tamassia, ***Algorithm Design: Foundations, Analysis, and Internet Examples***, 1st *Ed.*, John Wiley & Sons, 2001.
R2. U. Manber, ***Introduction to Algorithms: A Creative Approach***, 1st *Ed.*, Addison-Wesley, 1989.
R3. S. Sridhar, ***Design and Analysis of Algorithms***, 1st *Ed.*, Oxford University Press, 2014.
R4. G. Sharma, ***Design & Analysis of Algorithms***, 4th *Ed.*, Khanna Publishers, 2019.

Online Resources:

1. https://nptel.ac.in/courses/106106131: by Prof. M. Mukund, Chennai Mathematical Institute
2. https://nptel.ac.in/courses/106101060: by Prof. Ranade, Diwan, and Viswanathan, IIT Bombay
3. https://nptel.ac.in/courses/106105164: by Prof. S. Mukhopadhyay, IIT Kharagpur
4. https://web.stanford.edu/class/archive/cs/cs161/cs161.1138/
5. https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/

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

CO1	Design algorithms, analyze their running time for best, worst, and average-cases, and understand divide & conquer strategy considering quick sort and merge sort as examples.
CO2	Compare Heapsort with other comparison based sorting algorithms and develop dynamic programming algorithms.
CO3	Apply disjoint-set data structure and various algorithm design techniques such as greedy, backtracking, and branch-and-bound in real life problems.
CO4	Model a given engineering problem using graphs and design the corresponding algorithms to solve the problem.
CO5	Compare various pattern matching algorithms, understand NP-Completeness and the need of approximation algorithms.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Constitution of India	L-T-P	Credits	Marks
UMC	HS2001		2-0-0	0	100

Objectives	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.
Pre-Requisites	Basic knowledge of Indian history, overall idea on India's political system.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required and each session is planned to be interactive.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	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.	**8 Hours**
Module-2	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.	**6 Hours**
Module-3	State Government, The State Legislature - composition, powers and functions, State executive, Governor (with powers and functions).	**5 Hours**
Module-4	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.	**5 Hours**
Module-5	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.	**4 Hours**
	Total	**28 Hours**

Text Books:

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

Reference Books:

R1. M. Laxmikanth, ***Indian Polity***, 5th *Ed.*, McGraw Hill, 2011.
R2. P. M. Bakshi, ***The Constitution of India***, 14th *Ed.*, Universal Law Publishing Co, 2006.

Online Resources:

1. https://nptel.ac.in/courses/129106411: by Prof. S. Bhat, IIT Madras
2. https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf
3. https://www.india.gov.in/my-government/constitution-india/constitution-india-full-text
4. https://www.tutorialspoint.com/indian_polity/indian_polity_tutorial.pdf
5. 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	Understand the origins, values, features, rights, duties, and principles of the Indian Constitution.
CO2	Describe the federal structure and powers, roles, and functions of the legislature and executive.
CO3	Explain the structure and functions of State governments, legislatures, and the Governor.
CO4	Analyze constitutional amendments, provisions, key fundamental rights, and local bodies.
CO5	Evaluate the Indian judiciary, its structure, powers, independence, and role in judicial review.

Program Outcomes Relevant to the Course:

PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Java Programming Lab	L-T-P	Credits	Marks
PCR	CS2024		0-0-4	2	100

Objectives	The objective of the course is to apply object oriented programming principles and implement object oriented programming using Java programming language.
Pre-Requisites	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.
Teaching Scheme	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 / 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 and familiarization with Eclipse IDE for Java programming.
3	Use of class, data types, operators.
4	Use of control statements and conditionals.
5	Implement class, object.
6 - 7	Implementation of constructor, methods and use of OOP features.
8 - 10	Use of Inheritance Types, constructor, inheritance and super keyword, method overriding and use of final.
11	Practical use of abstract class.
11	Using Interface, Achieving multiple inheritance.
12	Implementation of package.
13 - 15	Exception handing fundamentals and java built-in exceptions, use of Scanner class for console input, Use of own Exception subclass.
16 - 18	Thread priority, implementation of synchronization and Implementation of user-defined thread.
19	I/O Basics, byte stream and character streams, reading and writing files.
20	Text processing using Java pre-defined StringBuilder and String Buffer classes.
21 - 24	GUI basics and Window fundamentals, working with different Components, Working with Container and Layout Managers, Event handling for interactive GUI application.
25 - 28	Project work on designing and developing a GUI based application.

Text Books:

T1. J. Keogh, ***J2EE: The Complete Reference***, 11th *Ed.*, McGraw-Hill Education, 2017.
T2. Y. D. Liang, ***Introduction to Java Programming***, 9th *Ed.*, Pearson Education, 2012.

Reference Books:

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

Online Resources:

1. https://nptel.ac.in/courses/106105191: Prof. D. Samanta, IIT Kharagpur
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/6-092-introduction-to-programming-in-java-january-iap-2010/

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

CO1	Apply object oriented principles to write Java programs for real-life applications.
CO2	Employ inheritance techniques for developing reusable software.
CO3	Develop robust & concurrent programs using exception handling and multi-threading.
CO4	Design programs using I/O operations, string classes, and collection framework.
CO5	Design GUI-based applications using Swing with database connectivity.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Design & Analysis of Algorithms Lab	L-T-P	Credits	Marks
PCR	CS2005		0-0-2	1	100

Objectives	The objective of this course is To implement various algorithms under different categories, analyze algorithms & their complexities, and implement string matching algorithms.
Pre-Requisites	Basic knowledge of C Programming and Data Structures is required.
Teaching Scheme	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 / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Sorting: Selection, Bubble and Insertion Sort
2	Implementation of Quick Sort
3	Implementation of Merge Sort
4	Implementation of Heap Sort
5	Matrix chain multiplication
6	Longest common subsequence
7	Fractional and 0/1 Knapsack Problem
8	Graph Traversal using BFS and DFS
9	Dijkstra's single source shortest path algorithm
10	Floyd Warshall's all pair shortest path algorithm
11	Kruskal's algorithm for Minimum Spanning Tree
12	Prim's Algorithm for Minimum Spanning Tree
13	N-queen's problem using backtracking
14	Naive and Rabin-Karp string matching algorithm

Text Books:

T1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, ***Introduction to Algorithms***, 3rd *Ed.*, PHI Learning, 2014.
T2. A. Levitin, ***Introduction to the Design and Analysis of Algorithms***, 3rd *Ed.*, Pearson, 2012.

Reference Books:

R1. A. V. Aho, J. E. Hopcroft, and J. D. Ullman, ***Data Structures and Algorithms***, 3rd *Ed.*, Pearson Education, 2006.
R2. D. E. Knuth, ***The Art of Computer Programming - Volumes 1 & 3***, Pearson Education, 2009.
R3. S. S. Skiena, ***The Algorithm Design Manual***, 2nd *Ed.*, Springer, 2008.

Online Resources:

1. https://nptel.ac.in/courses/106101060: by Prof. Ranade, Diwan, and Viswanathan, IIT Bombay
2. https://nptel.ac.in/courses/106106131: by Prof. M. Mukund, Chennai Mathematical Institute
3. http://www.cs.virginia.edu/~robins/CS_readings.html
4. https://ocw.mit.edu/courses/6-046j-design-and-analysis-of-algorithms-spring-2015/

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

CO1	Implement various searching and sorting algorithms and compare their execution time.
CO2	Understand and develop skill to solve problems using divide and conquer strategy.
CO3	Apply greedy, dynamic programming, backtracking and branch and bound paradigms to solve real life problems.
CO4	Formulate real life problems and solve them using different graph algorithms.
CO5	Implement and compare various pattern matching algorithms such as Naive, Rabin-Karp etc.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Soft Skills & Technical Writing	L-T-P	Credits	Marks
SEC	HS2002		0-0-4	2	100

Objectives	The objectives of this laboratory course are to impart important soft skills and to hone technical writing skills for developing research acumen and prepare the students to perform better in recruitment drives.
Pre-Requisites	Basic knowledge of English grammar and the ability to speak, read and write using the English language is required.
Teaching Scheme	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 & vocabulary enhancement.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	GD input and discussion.
2	Mock GD 1: content development.
3	Mock GD 2: group behaviour.
4	GD test and evaluation.
5	Presentation skills: review.
6-9	Delivering PowerPoint Presentations.
10	Writing an effective resume.
11	Writing a covering letter.
12	Personal Interviews: FAQs.
13-14	Mock Personal Interviews.
15	Reports: Importance, types, format and language.
16	Business Report: letter of transmittal.
17	Business Report: executive summary.
18	Business Proposals: importance, types, format.
19-20	Exercises on writing a proposal.
21	Features of research writing.
22	Elements of style in research writing.
23	Preparing works cited list as per MLA/APA.
24	Dealing with plagiarism.
25	The art of paraphrasing.
26-28	Group project presentation.

Text Books:

T1. M. A. Rizvi, ***Effective Technical Communication***, 2nd *Ed.*, McGraw-Hill Education, 2017.
T2. S. John, ***The Oxford Guide to Writing and Speaking***, 3rd *Ed.*, Oxford University Press, 2013.

Reference Books:

R1. B. K. Das, K. Samantray, R. Nayak, S. Pani, and S. Mohanty, ***An Introduction to Professional English and Soft Skills***, Cambridge University Press, 2009.
R2. B. K. Mitra, ***Communication Skills for Engineers***, Oxford University Press, 2011.
R3. The Modern Language Association of America, ***MLA Handbook***, 9th *Ed.*, MLA, 2021.
R4. D. S. Hegde (Ed), ***Essays on Research Methodology***, Springer, India, 2015.
R5. D. Ridley, ***The Literature Review: A Step-by-Step Guide for Students***, 2nd *Ed.*, Sage Publications, 2012.

Online Resources:

1. https://nptel.ac.in/courses/109104107/
2. https://nptel.ac.in/courses/109104031/
3. https://purdueglobalwriting.center/argumentative-writing/
4. https://caw.ceu.edu/online-writing-resources
5. https://communicationmgmt.usc.edu/blog/corporate-communication-resources/
6. https://owl.purdue.edu/owl/purdueowl.html
7. https://www.usingenglish.com/
8. http://www.english-test.net
9. https://www.ef.com/wwen/english-resources/

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

CO1	Understand and practice vital soft skills for professional success.
CO2	Participate well in the recruitment process successfully.
CO3	Understand aspects of public speaking and make impactful multimedia presentations.
CO4	Compose compelling resumes and persuasive cover letters.
CO5	Hone technical writing skills and get introduced to research writing.

Program Outcomes Relevant to the Course:

PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Operating Systems	L-T-P	Credits	Marks
PCR	CS3031		3-0-0	3	100

Objectives	The objectives of this course are to understand the fundamental concepts, techniques, algorithms along with internal working principles of Operating System as required by a Systems Engineer.
Pre-Requisites	Knowledge of computer programming and data structures is required.
Teaching Scheme	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

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Concept of operating system, Origin and evolution, Types, Resources managed, Services provided, System calls and their types, System structure of operating system.	**6 Hours**
Module-2	**Process Management**: Process concepts, States, PCB, types of schedulers, Operations on process, Inter-process communication, Concept of buffering, Thread overview, User & kernel threads, Multi-threading models, Issues with multi-threading; CPU Scheduling: Scheduling criteria, Scheduling algorithms – FCFS, SJF, SRTF, RR, Priority Scheduling, MLQ, MLQ with Feedback Scheduling.	**10 Hours**
Module-3	**Inter-Process Synchronization**: Bounded-buffer problem, Shared-memory solution to producer-consumer problem; Critical section problem: Peterson's solution, Synchronization hardware - TestAndSet() & swap(), Semaphores - binary & counting; Classical problems of synchronization: Bounded-Buffer, Readers-Writers, Dining-Philosophers, Monitor; Deadlock: Characterization, RAG, Deadlock Handling - Prevention, Avoidance, Banker's Algorithm, Deadlock detection and recovery.	**10 Hours**
Module-4	**Memory Management**: Logical and physical address space, Dynamic loading and linking, Swapping, Contiguous memory allocation, Overlays, Paging, Segmentation; Virtual Memory: Background, Demand paging, Page fault, Page replacement, Page replacement algorithms – FIFO, OPT, LRU, LRU-Approximation, LFU, MFU, Thrashing, Working-set model.	**9 Hours**
Module-5	**Secondary Storage Structure**: Overview of mass storage structure, Disk structure; Disk Scheduling: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK, RAID structure; File System: Access methods, Directory structure, Access control list, I/O System, Case study - LINUX System.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. A. Silberschatz, P. B. Galvin, and G. Gagne, ***Operating Systems Principles***, 7th *Ed.*, Wiley India, 2006.
T2. M. Milenkovic, ***Operating Systems: Concepts & Design***, 2nd *Ed.*, McGraw-Hill Education, 2001.

P.T.O

Reference Books:

R1. A. S. Tanenbaum, ***Modern Operating Systems***, 3rd *Ed.*, PHI Learning, 2007.
R2. P. B. Prasad, ***Operating Systems and System Programming***, 2nd *Ed.*, SciTech Publishres, 2015.

Online Resources:

1. https://nptel.ac.in/courses/106105214: by Prof. S. Chattopadhyay, IIT Kharagpur
2. https://nptel.ac.in/courses/106108101: by Prof. P. C. P. Bhatt, IISc Bangalore
3. https://nptel.ac.in/courses/106106144: by Prof. C. Rebeiro, IIT Madras
4. https://nptel.ac.in/courses/106102132: by Prof. S. Bansal, IIT Delhi
5. https://www.cse.iitb.ac.in/~mythili/os/: Notes & slides by Prof. M. Vutukuru, IIT Bombay
6. https://ocw.mit.edu/courses/6-828-operating-system-engineering-fall-2012/pages/lecture-notes-andreadings/

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

CO1	Explain operating system concepts, evolution, services, structures and system calls.
CO2	Analyze process management, inter-process communication, threads and CPU scheduling.
CO3	Apply synchronization techniques and deadlock handling methods in process management.
CO4	Analyze memory and virtual memory management, paging, segmentation and replacement.
CO5	Explain disk scheduling, file systems, I/O management and storage structures in OS.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Database Management Systems	L-T-P	Credits	Marks
PCR	CS3032		3-1-0	4	100

Objectives	The objective of this course is to learn principles of designing and using large scale database management systems for various real-world applications.
Pre-Requisites	Elementary knowledge of data structures and algorithms is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving & analysis.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Characteristics, Schema & Instances, Three-schema architecture, Data independence, Concept and types of data models, Database languages, Database users, System structure, E-R model, Constraints, Keys, Extended E-R model, Mapping of E-R model to relational schema.	**12 Hours**
Module-2	**Query Languages**: Introduction to relational model, Concepts of domain, Attributes, Tuples, Relations, Constraints (Domain, Key and Integrity constraints), Relational Algebra & its operations, Grouping & aggregation, Relational Calculus; Query processing and optimization - Evaluation of Relational Algebra expressions, Heuristic-based Query optimization.	**11 Hours**
Module-3	**Database Design & Normalization**: Purpose of normalization or schema refinement, Functional dependencies, Armstrong axioms, Attribute closure, Equivalence sets of FDS, Minimal cover; Normalization, Normal Forms – 1NF, 2NF, 3NF, and BCNF, Attribute & dependency preservation, Lossless join, Testing for lossless join, Multi-valued Dependency, 4NF & 5NF.	**12 Hours**
Module-4	**Transaction Processing & Recovery**: Basic concepts, Transaction State, ACID Properties, Concurrent Execution, Serializability; Concurrency Control Schemes - Lock-based and Timestamp-based protocols, Deadlock handling & prevention, Deadlock detection & recovery; Database Recovery - Types of failures, Log-based recovery, Check-points, Shadow paging.	**12 Hours**
Module-5	**Storage Strategies**: Storage Architecture, File and Record Organization, Spanned vs. Un-spanned organization, Types of Indexes – Primary, Secondary and Clustered indexing, B-Tree, B+ Tree, Static and Extendible Hashing, Collision resolution techniques.	**9 Hours**
	Total	**56 Hours**

Text Books:

T1. A. Silberschatz, H. F. Korth, and S. Sudarshan, ***Database System Concepts***, 6th *Ed.*, McGraw-Hill, 2013.
T2. R. Elmasri and S. B. Navathe, ***Fundamentals of Database Systems***, 7th *Ed.*, Pearson Education, 2016.

Reference Books:

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

Online Resources:

1. https://nptel.ac.in/courses/106105175: by Prof. P. P. Das & Prof. S. Chattopadhyay, IIT Kharagpur
2. https://nptel.ac.in/courses/106106220: by Prof. S. Kumar, IIT Madras

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

CO1	Explain database architecture, data models, E-R modeling, constraints and schema mapping.
CO2	Apply relational algebra and calculus for query formulation, processing and optimization.
CO3	Analyze functional dependencies and apply normalization to achieve optimal database design.
CO4	Explain transaction processing, concurrency control, deadlock handling and recovery.
CO5	Analyze storage structures and implement indexing & hashing for better query performance.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Artificial Intelligence	L-T-P	Credits	Marks
PCR	CS3033		3-0-0	3	100

Objectives	The objective of this course is to provide a strong foundation to Artificial Intelligence methods to build intelligent systems with perception, logic, reasoning and learning abilities.
Pre-Requisites	Knowledge of mathematics, algorithms and data structures is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, sessions are planned to be interactive with problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction & Uninformed Search**: Definitions of AI, Four approaches to AI, Turing Test; Intelligent Agents - Agent function & programs, Rationality, Environment types, PEAS description, Structure of agents, Types of agent programs, Problems solving by searching - Example problems, State space search; Uninformed Search Strategies - BFS, DFS, Depth limited, Iterative deepening DFS, Uniform cost, Bi-directional searches.	**9 Hours**
Module-2	**Searching & Reasoning**: Introduction, Evaluation & heuristic functions, Greedy best first search, A* search, Example problems; Local Search Algorithms - Hill climbing search and simulated annealing; Constraint Satisfaction Problems - Introduction & types, Backtracking search for CSPs; Adversarial Search - Game playing, Minimax and α-β pruning.	**9 Hours**
Module-3	**Knowledge, Logic & Reasoning**: KB-based agents, Wumpus world problem, Logic, Propositional logic, First order logic (FOPL) - Syntax and Semantics, Inference in FOPL, Forward and backward chaining, Knowledge Representation: Categories and objects, Semantic nets, Frames.	**8 Hours**
Module-4	**Planning & Uncertainty**: Planning problem, Planning with state-space search, Partial order planning, Planning graphs, Hierarchical planning; Uncertain Knowledge - Acting under uncertainty, Bayes rule & its use; Probabilistic reasoning, Representing Knowledge in Uncertain Domain, Semantics of Bayesian networks.	**8 Hours**
Module-5	**Learning & Expert Systems**: Learning agent, Paradigms of learning, Learning from observations, Inductive learning, Decision trees, Information gain, Instance based learning, Neural networks - Introduction, Perceptron, Introduction to Reinforcement learning; Introduction to Expert Systems – Definition, Architecture, Applications.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. S. J. Russell and P. Norvig, ***Artificial Intelligence - A Modern Approach***, 4th *Ed.*, Pearson Education, 2020.

T2. D. W. Patterson, ***Introduction to Artificial Intelligence & Expert Systems***, Pearson Education, 2015.

Reference Books:

R1. E. Rich, K. Knight, and S. B. Nair, ***Artificial Intelligence***, 3rd *Ed.*, McGraw Hill, 2017.
R2. M. Negnevitsky, ***Artificial Intelligence: A Guide to Intelligent Systems***, 3rd *Ed.*, Addison Wesley, 2011.

Online Resources:

1. https://nptel.ac.in/courses/106102220/: by Prof. Mausam, IIT Delhi.
2. https://nptel.ac.in/courses/106106140/: by Prof. D. Khemani, IIT Madras.
3. https://nptel.ac.in/courses/106105079/: by Prof. P. Dasgupta, IIT Kharagpur.
4. https://nptel.ac.in/courses/106105077/: by Prof. A. Basu and Prof. S. Sarkar, IIT Kharagpur.

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

CO1	Analyze intelligent agents, environments and solve problems using uninformed search.
CO2	Utilize search strategies for problem solving in games and constraint satisfaction tasks.
CO3	Employ propositional and FOPL for reasoning and knowledge representation.
CO4	Apply planning strategies and uncertain reasoning to address real-world challenges.
CO5	Leverage AI learning methods to solve practical problems and design expert systems.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Software Engineering	L-T-P	Credits	Marks
PCR	CS3034		3-0-0	3	100

Objectives	The objective of this course is to learn and implement software engineering practices including different phases of software product creation, maintenance and project management activities undertaken in software development organizations.
Pre-Requisites	Basics of logic, programming languages, and database systems is required.
Teaching Scheme	Regular classroom lectures with use of ICT as required, sessions are planned to be interactive with focus on case-studies and discussions on the latest trends.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Software Engineering**: Introduction, Abstraction, Decomposition, Evolution of software engineering, Process Framework, SDLC models - Waterfall, Iterative, V-Process, Incremental, Evolutionary (Prototyping & Spiral), Agile (Extreme programming, Crystal, Scrum) & RAD models, Unified process.	**8 Hours**
Module-2	**Requirements Engineering**: Stages of requirements engineering, Requirement gathering, analysis and specification, SRS document, Functional & Non-functional requirements, Decision trees & Decision tables, Formal specification (Axiomatic specs for Stacks & Queues).	**8 Hours**
Module-3	**Software Project Management**: Software project planning, Project size estimation (Cost, Time, Effort), COCOMO model, Project scheduling: Activity network diagram, Critical Path Method, Estimation techniques (Algorithmic, Empirical, Expert judgment, Analogical, Top-down & Bottom-up methods).	**8 Hours**
Module-4	**Design, Coding and Testing**: Function-oriented software design (HLD and DD), DFDs, Structure charts, Characteristics of a good design, Cohesion & Coupling; Coding - Coding standards and guidelines, Code inspection & walkthrough; Software Testing - Introduction, Verification & Validation, Black-Box testing (Equivalence class partitioning and Boundary value analysis), White-Box testing (Statement, Branch, Condition, Path coverage, Control flow graph and Cyclomatic complexity), Unit, Integration and System testing, Basis path, Regression and Mutation testing, Error seeding.	**10 Hours**
Module-5	**Maintenance & Quality Control**: Maintenance types, Reverse engineering & Re-Engineering; SEI-Capability Maturity Model, Software Quality – Quality assurance and Quality control, Six sigma, Risk engineering and matrix, Software reliability.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. R. Mall, ***Fundamentals of Software Engineering***, 5th *Ed.*, PHI Learning, 2018.

T2. R. S. Pressman, ***Software Engineering - A Practitioner's Approach***, 7th *Ed.*, McGraw Hill Education, 2010.

T3. B. Hughs and M. Cotterell, ***Software Project Management***, 1st *Ed.*, Ingram Publications, 2009.

Reference Books:

R1. I. Somerville, ***Software Engineering***, 10th *Ed.*, Pearson Education, 2017.
R2. R. C. Martin, ***Clean Code: A Handbook of Agile Software Craftsmanship***, 10th *Ed.*, PHI Learning, 2017.

Online Resources:

1. https://nptel.ac.in/courses/106101061: by Prof. R. K. Joshi, et.al., IIT Bombay.
2. https://nptel.ac.in/courses/106105182: by Prof. R. Mall, IIT Kharagpur.
3. https://nptel.ac.in/courses/106101163: by Prof. M. D'souza, IIIT Bangalore.

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

CO1	Analyze the SDLC models and apply the suitable model while creating a software product.
CO2	Apply requirement analysis techniques to gather, analyze and specify system requirements.
CO3	Comprehend project management activities, applying them for cost, time and effort estimations.
CO4	Create the design artifacts using proven methodologies followed by construction and testing.
CO5	Implement maintenance, quality and risk engineering activities to gain competitive advantage.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Organizational Behaviour	L-T-P	Credits	Marks
UCR	HS3003		3-0-0	3	100

Objectives	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.
Pre-Requisites	General knowledge of any organization and its operations is sufficient.
Teaching Scheme	Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with real-life examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Organizational Behaviour (OB), Concept, Importance, Learning – Nature and Components of Learning, Learning Cycle, Theories of Learning; Personality - Concept, Determinants of Personality, Personality Traits, Personality and OB.	**9 Hours**
Module-2	**Perception & Motivation**: 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.	**8 Hours**
Module-3	**Process and Leadership**: Communication Concepts, 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 Decision-making with Managerial Implications, Effective Team Building; Leadership - Leadership and Management, Theories of Leadership, Conflict-Nature of Conflict and Conflict Resolution.	**9 Hours**
Module-4	**Culture & HR Management**: Concepts of Organizational Culture and Organizational Effectiveness; HR Management – Selection, Orientation, Training and Development, Performance Appraisal.	**8 Hours**
Module-5	**Organizational Change**: Importance of Change, Planned Change and OB techniques; International OB - Cultural Differences and Similarities, Individual and Interpersonal Behavior in Global Perspective, Trends in International Business.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. K. Davis, ***Organisational Behaviour***, 9th *Ed.*, McGraw-Hill, 1992.
T2. K. Aswathappa, ***Organisational Behaviour***, 12th *Revised Ed.*, Himalaya Publishing House, 2016.

Reference Books:

R1. S. P. Robbins, ***Organisational Behaviour***, 8th *Ed.*, Prentice Hall of India, 2018.
R2. K. B. L. Srivastava and A. K. Samantaray, ***Organizational Behaviour***, 1st *Ed.*, India Tech, 2009.
R3. K. Singh, ***Organizational Behaviour***, 3rd *Ed.*, Pearson, 2015.

Online Resources:

1. https://nptel.ac.in/courses/110105033: by Dr. S. Mukhopadhyay, IIT Kharagpur
2. https://nptel.ac.in/courses/110105034: by Dr. S. Mukhopadhyay, IIT Kharagpur
3. https://nptel.ac.in/courses/110103433: by Prof. A. C. Issac, IIT Guwahati

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

CO1	Explain the concepts with micro and macro approaches to behavior in organizations.
CO2	Analyze the models used for individual motivation, learning, perception and personality.
CO3	Apply communication, teamwork, leadership and conflict resolution for effectiveness.
CO4	Explain organizational culture and HR practices for team building and leadership.
CO5	Illustrate organizational culture and analyze processes and barriers to change.

Program Outcomes Relevant to the Course:

PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Operating Systems Lab	L-T-P	Credits	Marks
PCR	CS3035		0-0-2	1	100

Objectives	The objective of this laboratory course is to learn operating system level programming and provide a hands-on exposure on implementation of various algorithms of the operating system.
Pre-Requisites	Knowledge of programming language, data structures, and concepts of operating systems taught in the theory class are required.
Teaching Scheme	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 / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to Linux OS and basic VI editor commands.
2	Linux File Structure and advance Linux commands.
3	Introduction to UNIX Shell Script: Arithmetic Expressions, Relational and Conditional Operators.
4	UNIX Shell Script: Looping & Switch Cases.
5	Process Creation, Process handing, Process signaling through fork() & exec().
6	CPU Scheduling (Non-Pre-emptive): FCFS, SJF & Priority.
7	CPU Scheduling (Pre-emptive): SRTF, RR & Priority-based preemptive.
8	Multi-Threaded application using POSIX threads.
9	Synchronization using Semaphore (Producer-Consumer, Reader-Writer).
10	Message passing: Pipe & Signals.
11	Inter-Process Communication using Shared memory.
12	Deadlock implementation: Banker's Algorithm.
13	Implementation of Page Replacement Algorithms.
14	Implementation of Disk scheduling Algorithms.

Text Books:

T1. V. Mukhi, ***The C Odyssey: UNIX***, 1st *Ed.*, BPB Publications, 2004.
T2. A. Silberschatz, P. B Galvin, and G Gagne, ***Operating Systems Principles***, 7th *Ed.*, Wiley India, 2006.

Reference Books:

R1. A. S. Tanenbaum, ***Modern Operating Systems***, 3rd *Ed.*, PHI Learning, 2007.
R2. P. B. Prasad, ***Operating Systems and System Programming***, 2nd *Ed.*, SciTech Publishres, 2015.

Online Resources:

1. https://nptel.ac.in/courses/106105214: by Prof. S. Chattopadhyay, IIT Kharagpur
2. https://nptel.ac.in/courses/10610810: by Prof. P. C. P. Bhatt, IISc Bangalore
3. https://people.iitism.ac.in/~download/lab%20manuals/cse/CSC211.pdf
4. http://web.stanford.edu/~ouster/cgi-bin/cs140-spring14/lectures.php

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

CO1	Perform various tasks using commands in a Linux operating system environments.
CO2	Write, debug and execute UNIX shell scripts for given problems.
CO3	Implement scheduling algorithms used at the operating system level.
CO4	Write programs for creation of child processes and communication among them.
CO5	Implement deadlock avoidance and detection algorithms.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Database Management Systems Lab	L-T-P	Credits	Marks
PCR	CS3036		0-0-4	2	100

Objectives	The objective of this course is to provide a strong foundation in database design, querying, and data manipulation, along with hands-on experience with the skills required to become proficient database application developers.
Pre-Requisites	Knowledge of programming, data structures, and relational databases is required.
Teaching Scheme	Regular laboratory sessions will be conducted under the supervision of the instructor, focusing on programming-based assignments and practical experiments.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to relational databases and structured query language.
2	Basic DML commands: Simple Select queries for data retrieval.
3	Advanced SELECT queries: Using WHERE, ORDER BY and DISTINCT.
4	Functions in SQL: Single-row & Multi-row functions for data retrieval.
5	Aggregate functions: Queries using GROUP BY and HAVING clauses.
6, 7	Nested Queries and Subqueries: Scalar and Correlated subqueries.
8	DDL commands: CREATE, ALTER and manipulate design of tables.
9, 10	DML commands: INSERT, UPDATE & DELETE on the created table.
11	Constraints: Primary key, foreign key, unique, check and not null constraints on tables.
12, 13	JOIN: Retrieve data from multiple tables using various types of JOIN operations.
14	Views: CREATE, ALTER & Manage Views from single & multiple tables.
15	Indexes: Creating and managing indexes for performance optimization.
16	Sequences: Using sequences in relational databases.
17	DCL queries: Using GRANT and REVOKE for permissions on tables.
18	Set operations: UNION, INTERSECT and EXCEPT queries.
19	Introduction to PL/SQL: Identifiers, Literals and Keywords.
20, 21	PL/SQL loops and conditional statements.
22	Exception handling in PL/SQL blocks.
23	PL/SQL block by using numeric, string & other miscellaneous datatypes.
24, 25	Cursors: Use of implicit & explicit cursors in PL/SQL.
26	Stored Procedures: Write PL/SQL block using procedures.
27, 28	Triggers: Creating BEFORE & AFTER row-level triggers.

Text Books:

T1. S. Saxena, ***Essential PostgreSQL***, 1st *Ed.*, BPB Publications, 2025.
T2. M. S. Hussain, ***PostgreSQL 15 Cookbook***, 1st *Ed.*, BPB Publications, 2024.
T3. R. Obe and L. Hsu, ***PostgreSQL: Up and Running***, 3rd *Ed.*, Shroff/O'Reilly, 2017.

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Reference Books:

R1. S. Valeja and D. Gonzalez, ***PostgreSQL for Jobseekers***, 1st *Ed.*, BPB Publications, 2023.
R2. L. Ferrari and E. Pirozzi, ***Learn PostgreSQL***, 2nd *Ed.*, Packt Publishing, 2023.
R3. H. -J. Schönig, ***Mastering PostgreSQL 12***, 3rd *Ed.*, Packt Publishing, 2019.

Online Resources:

1. https://nptel.ac.in/courses/106106095: by Prof. P. S. Kumar, IIT Madras
2. https://nptel.ac.in/courses/106105175: by Prof. P. P. Das and others, IIT Kharagpur
3. https://www.postgresql.org/docs/online-resources/

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

CO1	Write SQL queries to retrieve & manipulate data with single & multi-row functions.
CO2	Create relational database with integrity constraints and query data from multiple tables.
CO3	Create views, sequences and indexes to optimize database performance.
CO4	Develop PL/SQL programs for problem-solving and simplifying complex queries.
CO5	Construct PL/SQL programs with cursors and triggers to ensure data integrity.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Programming in Python Lab	L-T-P	Credits	Marks
PCR	CS3037		0-0-4	2	100

Objectives	The objective of this laboratory course is learn the necessary skills and tools of the Python programming language, solve problems applying fundamental concepts in computational and data-driven tasks.
Pre-Requisites	Knowledge of programming and problem-solving skills is required.
Teaching Scheme	Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise programming assignments. Concepts are to be taught hands-on in the laboratory, along with the provision of course materials.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Fundamentals: write, compile, test & debug basic programs.
2	Programs using data types and operators.
3	Programs using string handling operators and functions.
4-5	Conditional constructs: if, if-else, elif & nested if.
6-7	Programs on loop-control structures using for and while loops.
8	Lists: operations, comprehension, simple application and matrix representation.
9-10	Tuples and sets: operations and simple applications.
11	Dictionaries: operations and simple applications.
12	Functions: definition, calling, parameter variations.
13	Programs using recursive functions.
14	Modules: using built-in modules, creating and importing a simple module.
15	Develop programs using Packages.
16	Programs on creating and using Class and Object.
17	Formulate problems on Inheritance and write programs.
18	File operations: read, write, append, operations on file contents.
19	Exception handling: syntax, usage, application.
20	Pattern matching using regular expressions.
21	Develop a simple graphical user interface using Tkinter.
22-23	Programs on database connectivity.
24-25	NumPy basics: arrays, indexing, simple matrix operations.
26	Data handling with Pandas: reading, statistics, filtering, plotting and visualization.
27-28	Mini Project: combine Pandas and Matplotlib.

Text Books:

T1. R. Thareja, ***Python Programming Using Problem-Solving Approach***, 3rd *Ed.*, Oxford University Press, 2025.

T2. S. Sridhar, J. Indumathi, and V. M. Hariharan, ***Python Programming***, 1st *Ed.*, Pearson Education, 2023.

T3. A. Downey, J. Elkner, and C. Meyers, ***Learning with Python***, 1st *Ed.*, Wiley India, 2015.

Reference Books:

R1. M. Sundarrajan, M. D. Choudhry, S. Jeevanandham, and A. Jothi, ***Python Programming: Beginners Guide***, 1st *Ed.*, Notion Press, 2024.
R2. E. Matthes, ***Python Crash Course***, 3rd *Ed.*, No Starch Press, 2023.
R3. P. Barry, ***Head First Python***, 2nd *Ed.*, O'Reilly Media, 2016.

Online Resources:

1. https://nptel.ac.in/courses/106106145: Prof. M Mukund, IIT Madras
2. https://nptel.ac.in/courses/106106182: Prof. S Iyengar, IIT Ropar
3. https://gnindia.dronacharya.info/IT/NC-Course-2nd-Year/Downloads/Python-Programming/Books/Python-Programming.pdf: by AICTE

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

CO1	Develop programs using fundamental concepts of the Python programming language.
CO2	Apply functions, modules and packages to develop modular and reusable programs.
CO3	Demonstrate file operations, exception handling and pattern matching for applications.
CO4	Design and construct graphs using essential Python libraries.
CO5	Develop and test applications related to real-world problems.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Operations Research	L-T-P	Credits	Marks
PCR	MT3002		3-0-0	3	100

Objectives	The objective of this course is to learn linear & non-linear programming with several standard numerical methods and apply suitable tools to solve large scale optimization problems.
Pre-Requisites	Knowledge of calculus of several variables, 2D & 3D coordinate geometry and matrix algebra is required.
Teaching Scheme	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

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Linear Programming**: Graphical, Simplex & Big-M Methods, Alternate Optima, Redundancy & Degeneracy.	**8 Hours**
Module-2	**Simplex & Dual Methods**: Simplex Method Algorithm, Dual Problem, Construction of Dual, Duality Theorem (without proof), Dual Simplex Method, Post Optimal Analysis.	**8 Hours**
Module-3	**Transportation & Assignment Models**: The Transportation Problem – Mathematical Formulation, Finding an Initial Basic Feasible Solution, North West Corner Rule, Least Cost Rule, Vogel's Approximation Method, Test for Optimality, The u-v Method, Stepping Stone Method, Assignment Problem, Hungarian Method, Travelling Salesman Problem.	**10 Hours**
Module-4	**Integer & Dynamic Programming**: Gomory's Cutting Plane Method for Different IPP, Branch & Bound Method; Deterministic Dynamic Programming - Mathematical Description, Problems of Different Types Solved by DP Methods.	**8 Hours**
Module-5	**Quadratic & Unconstrained Optimization**: Wolfe's method for Quadratic Programming Problem, Optimality Conditions, Lagrangian & Lagrange Multipliers, Karush–Kuhn–Tucker Necessary/Sufficient Optimality Conditions; Unconstrained Optimization - Line Search Methods for Uni-Modal Functions, The Steepest Descent Method, Newton's Method.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. S. Chandra, Jayadeva, and A. Mehera, ***Numerical Optimization with Applications***, 1st *Ed.*, Narosa Publishing House, 2013.

T2. A. Ravindran, D. Phillips, and J. J. Solberg, ***Operations Research: Principle and Practice***, 2nd *Ed.*, Wiley India, 2010.

T3. H. A. Taha, ***Operations Research: An Introduction***, 9th *Ed.*, Pearson Education, 2012.

Reference Books:

R1. D. G. Luenberger and Y. Ye, ***Linear & Nonlinear Programming***, 3rd *Ed.*, Springer, 2008.

R2. S. S. Rao, ***Engineering Optimization***, 4th *Ed.*, New Age Publishers, 2009.

R3. K. Dev, ***Optimization for Engineering Design***, 2nd *Ed.*, Prentice Hall India, 2012.

Online Resources:

1. https://nptel.ac.in/courses/111107128: by Prof. K. Deep, IIT Roorkee
2. https://nptel.ac.in/courses/126105663: by Prof. R. Singh, IIT Kharagpur
3. https://nptel.ac.in/courses/108106478: by Prof. U. K. Khankhoje, IIT Madras
4. https://nptel.ac.in/courses/111104165: by Prof. D. Ghosh, IIT(BHU) Varanasi

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

CO1	Solve linear programming problems using graphical and simplex methods.
CO2	Apply simplex, dual, and dual-simplex methods and interpret post-optimality results.
CO3	Solve transportation, assignment, and TSP problems using BFS methods and optimality tests.
CO4	Apply integer programming & dynamic programming methods to solve optimization problems.
CO5	Apply quadratic and unconstrained optimization techniques using standard optimality methods.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Networks	L-T-P	Credits	Marks
PCR	CS3038		3-0-0	3	100

Objectives	The objective of this course is to learn the concepts of computer networks and develop an understanding of modern network architectures from design and performance perspective.
Pre-Requisites	Basic knowledge of a computer system and Internet is required.
Teaching Scheme	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

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Data Communication Components**: Representation of data and its flow in a Networks, Network Topology, Protocols & Standards, OSI model, Transmission Media, LAN - Wired LAN, Wireless LANs, Connecting LAN & Virtual LAN; Bandwidth Utilization – FDM, TDM, WDM, Spread spectrum.	**10 Hours**
Module-2	**Data Link Layer**: Medium Access Sub Layer, Error Detection & Correction - Fundamentals, Block coding, Hamming Distance, Checksum and CRC; Data Link Control and Protocols – Framing, HDLC; Flow and Error control protocols – Stop-and-Wait, Go-back–N and Selective Repeat ARQ, Sliding Window and Piggybacking; Multiple Access Protocols - Pure ALOHA, CSMA, CSMA-CD & CSMA-CA.	**10 Hours**
Module-3	**Network Layer**: Switching, IPV4 & IPV6 addressing; Error reporting and Management protocols - ICMP & IGMP; Address mapping - ARP, RARP, Bootstrap protocol & DHCP; Delivery, Forwarding, Unicast Routing protocols - Distance vector routing, Linked state routing.	**9 Hours**
Module-4	**Transport Layer**: Process-to-Process Communication, UDP, TCP, SCTP, Congestion Control, Quality of Service, QoS improving techniques - Leaky & Token Bucket algorithms.	**7 Hours**
Module-5	**Application Layer**: Domain Name Space (DNS), DDNS, TELNET, EMAIL, FTP, WWW, HTTP, SNMP, Basics of Firewalls, Introduction to Cybersecurity.	**6 Hours**
	Total	**42 Hours**

Text Books:

T1. B. A. Forouzan, ***Data Communication and Networking***, 6th *Ed.*, McGraw–Hill, 2022.
T2. A. S. Tannenbaum and D. Wetherall, ***Computer Networks***, 5th *Ed.*, Prentice Hall, 2016.

Reference Books:

R1. L. L. Peterson and B. S. Davie, ***Computer Networks: A Systems Approach***, 5th *Ed.*, Morgan Kaufmann, 2011.
R2. W. Stallings, ***Data and Computer Communications***, 10th *Ed.*, Pearson Education, 2017.
R3. B. A. Forouzan and F. Mosharraf, ***Computer Networks: A Top-Down Approach***, McGraw-Hill Education, 2017.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/106105081: by Prof. S. Ghosh, IIT Kharagpur
2. https://nptel.ac.in/courses/106105082: by Prof. A. Pal, IIT Kharagpur
3. https://nptel.ac.in/courses/106105183: by Prof. S. K. Ghosh & Prof. S. Chakraborty, IIT Kharagpur

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

CO1	Explain data communication, OSI layers, topologies, transmission media and bandwidth use.
CO2	Apply the error detection, flow control, framing, HDLC and multiple access in data link layer.
CO3	Implement network layer protocols, IPv4/IPv6 addressing, error control, mapping and routing.
CO4	Explain transport layer protocols, congestion control, QoS and flow control techniques.
CO5	Recognize the application layer protocols, DNS, web services, security basics and bluetooth.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Organization & Architecture	L-T-P	Credits	Marks
PCR	CS3039		3-0-0	3	100

Objectives	The objective of this course is study hardware design, logic design, basic structure and behavior of various functional modules of a modern digital computer and how they interact to process instructions of the user.
Pre-Requisites	Knowledge of basic digital electronics and computer fundamentals is required.
Teaching Scheme	Regular classroom lectures with use of ICT wherever required, and planned interactive sessions with focus on critical thinking & problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Basic structures of Computers**: Computer architecture vs. Computer organization, Functional units, Operational concepts, Registers, Bus structure, Performance consideration, SPEC rating.	**7 Hours**
Module-2	**Memory Location & Addresses**: Big-endian & Little-endian representations, Instruction format, Instruction set architecture, Case study – instruction sets of some common CPUs, RISC vs. CISC, Addressing modes, Instruction Sequencing, Subroutines.	**8 Hours**
Module-3	**Binary Arithmetic**: Addition & subtraction of signed numbers, Design of fast adders, Multiplication of positive numbers, signed operand multiplication, Fast multiplication, Integer division, Representation of floating-point numbers.	**10 Hours**
Module-4	**Memory System**: Concepts, Speed, Size and Cost, Semiconductor memory technologies: Internal organization of the memory chips, Construction of larger memory, Cache memory concepts, Cache memory mapping techniques, Performance consideration; Virtual memory - Concepts, Address translation, Replacement techniques.	**9 Hours**
Module-5	**Basic Processing Units**: Fundamental concepts, Execution cycle, Single-bus & Multi-bus organizations, Execution of complete instruction, Hardwired control, Micro programmed control, Input-output subsystems, I/O device interface, I/O transfers.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. C. Hamacher, Z. Vranesic, and S. Zaky, ***Computer Organization***, 5th *Ed.*, McGraw-Hill, 2011.
T2. W. Stallings, ***Computer Organization and Architecture***, 9th *Ed.*, Prentice Hall India, 2012.

Reference Books:

R1. M. M. Mano, ***Computer System Architecture***, 3rd *Ed.*, PHI, 2007.
R2. B. Govindarajalu, ***Computer Architecture and Organization***, 5th *Ed.*, Tata McGraw-Hill, 2004.
R3. N. P. Carter, ***Schaum's Outline of Computer Architecture***, McGraw-Hill Education, 2002.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/106102157: by Prof. S. R. Sarangi, IIT Delhi
2. https://nptel.ac.in/courses/106106166: by Prof. Kamakoti, IIT Madras
3. https://nptel.ac.in/courses/106105163: by Prof. I. Sengupta and Prof. K. Datta, IIT Kharagpur

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

CO1	Explain computer architecture, basic units, registers, buses, operations, and performance.
CO2	Interpret instruction formats and apply addressing modes to solve basic problems.
CO3	Understand binary arithmetic, signed operations, and design of fast adders and multipliers.
CO4	Analyze memory hierarchy, cache & virtual memories, mapping and replacement techniques.
CO5	Describe CPU structure, control methods, and mechanisms for I/O interfacing and transfers.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Data Mining & Data Warehousing	L-T-P	Credits	Marks
PEL	CS3043		3-0-0	3	100

Objectives	The objective of this course is to analyze of large, complex, information-rich data in various domains, study the concepts and applications of data warehouse and discover useful patterns by applying data mining techniques.
Pre-Requisites	Knowledge of database management systems, probability, statistics and programming language are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with problem solving and real-life examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Data Warehousing**: Concepts, Applications, Difference between operational database and Data warehouses, OLTP & OLAP systems, 3-tier architecture, ETL Process, Data Marts, Data staging area, Metadata.	**8 Hours**
Module-2	**Data Mining**: Concepts, Applications, KDD process, Data Objects and attributes types, Basic Statistical Descriptions of Data: Central tendency - Variation, Spread, Standard deviation and Boxplot; Data similarity, Data Pre-processing - Data cleaning, Binning, Integration, Reduction and Transformation, Correlation Analysis - Pearson's coefficient, Chi-Square and Covariance.	**10 Hours**
Module-3	**Mining Frequent Patterns**: Introduction, Market basket analysis, Association rule mining, Support, Confidence, Lift, Frequent item-sets, Closed Item-sets, Maximal Item-set and generation, Apriori & FP-Growth algorithms, Evaluation of association patterns, Association and correlation analysis.	**8 Hours**
Module-4	**Classification**: Concepts, Applications, Decision tree induction, Information gain, Bayes theorem, Naïve Bayesian classifier, K Nearest Neighbor; Classification evaluation techniques (Confusion matrix – Precision, Recall and F-Measure), Handling the class imbalance problem (Oversampling, Undersampling, Threshold moving and Ensemble techniques).	**8 Hours**
Module-5	**Clustering**: Concepts, Applications, Partition-based clustering: K-Means & K-Medoid algorithms, Hierarchical clustering: Agglomerative & Divisive methods, Density-based Clustering: DBSCAN, Graph-based clustering, Clustering evaluation techniques (Silhouette coefficient & Dunn's index).	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. J. Han, M. Kamber, and J. Pei, ***Data Mining: Concepts and Techniques***, 3rd *Ed.*, Morgan Kaufmann, 2011.

T2. R. Thareja, ***Data Warehousing***, 1st *Ed.*, Oxford University Press, 2009.

P.T.O

Reference Books:

R1. A. Berson and S. J. Smith, ***Data Warehousing, Data Mining & OLAP***, 1st *Ed.*, McGraw Hill Education, 2017.
R2. P. N. Tan, M. Steinbach, A. Karpatne, and V. Kumar, ***Introduction to Data Mining***, 2nd *Ed.*, Pearson Education, 2019.

Online Resources:

1. https://nptel.ac.in/courses/106105174/: by Prof. P. Mitra, IIT Kharagpur
2. https://nptel.ac.in/courses/110107092: by Prof. G. Dixit, IIT Roorkee
3. http://infolab.stanford.edu/~ullman/mining/2003.html: notes by Stanford University
4. https://www.cse.iitb.ac.in/~krithi/courses/631/anand.ppt: by Prof. A. Deshpande, IIT Bombay

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

CO1	Describe the concepts and applications of Data Warehouse and its components.
CO2	Explain data mining concepts, preprocessing, data analysis, correlation and applications.
CO3	Construct frequent patterns and association rules by discovering correlations among data.
CO4	Compare key classification algorithms and apply them to real life problems in multiple domains.
CO5	Apply different clustering algorithms for solving real life problems in various domains.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Simulation & Modelling	L-T-P	Credits	Marks
PEL	CS3044		3-0-0	3	100

Objectives	The objective of this course is to provide knowledge of discrete and continuous systems, random number generation, queuing system and computer system simulation.
Pre-Requisites	Knowledge of Probability, Statistics and Operations Research is required.
Teaching Scheme	Regular class room lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Advantages & disadvantages of Simulation, Areas of application, Systems and System environment, Components of a system, Discrete & continuous systems, Model of a system, Types of models, Steps in a simulation study, Simulation examples - Simulation of queuing and Inventory systems, Other simulation examples.	**9 Hours**
Module-2	**General Principles & Random Numbers**: Concepts in discrete event simulation, Event scheduling/time advance algorithm, Simulation using event scheduling; Random Numbers - Properties and Generation methods; Tests for Random number – Frequency, Runs & Autocorrelation tests.	**8 Hours**
Module-3	**Random Variate Generation**: Inverse transform technique - Exponential, Uniform and Weibull; Triangular distributions, Direct transformation for Normal & Log Normal Distributions, Convolution methods - Erlang distribution; Acceptance rejection technique; Optimisation via Simulation - Meaning, Difficulty, Robust Heuristics and Random Searches.	**9 Hours**
Module-4	**Analysis of Simulation**: Data input Modelling - Data collection, Identification and distribution with data, Parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis; Verification & Validation of Model - Model Building, Verification, Calibration and Validation of Models.	**9 Hours**
Module-5	**Output Analysis & Simulation Software**: Types of Simulations wrt Output Analysis, Stochastic nature of output data, Measures of performance & their estimation, Output analysis of terminating & steady state simulations; Simulation Software - Selection of simulation software, Simulation packages, Trends in simulation software.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. J. Banks, J. S. Carson II, B. L. Nelson, and D. M. Nicol, ***Discrete Event System Simulation***, 5th *Ed.*, Prentice Hall, 2014.

T2. G. Gordon, ***System Simulation***, 2nd *Ed.*, Prentice Hall, 1978.

P.T.O

Reference Books:

R1. A. M. Law and W. D. Kelton, ***Simulation Modeling & Analysis***, 4th *Ed.*, McGraw Hill, 2018.
R2. N. Deo, ***Systems Simulation with Digital Computer***, 3rd *Ed.*PHI Publication, 2004.

Online Resources:

1. https://nptel.ac.in/courses/112107220: by Prof. P. K. Jha, IIT Roorkee
2. https://cspages.ucalgary.ca/~cwill/CPSC531/slides.html

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

CO1	Explain system concepts, types of models, and steps involved in a simulation study.
CO2	Understand event-scheduling concepts and validate random numbers for simulation models.
CO3	Generate random variates using standard techniques and apply simulation for optimization.
CO4	Apply data modeling, parameter estimation, and model verification and validation techniques.
CO5	Interpret simulation results and select appropriate software tools for simulation modeling.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Mobile Computing	L-T-P	Credits	Marks
PEL	CS3045		3-0-0	3	100

Objectives	The objective of this course is to learn and implement key mobile computing paradigms, applications, limitations and GSM-based infrastructure followed by the challenges, solutions across MAC, network & transport layers, Ad-hoc networks and database issues in mobile environments.
Pre-Requisites	Basic knowledge of computer networks, OS and DBMS is required.
Teaching Scheme	Regular classroom lectures with use of ICT as required; sessions are planned to be interactive with focus on examples, case-studies and latest trends.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Cellular Networks & Protocols**: Personal Communication Systems - Wireless technologies, Signals and Frequency; Cellular Systems - Structure, Cluster, Frequency reuse and splitting; MAC Mechanisms - SDMA, FDMA, TDMA & CDMA; GSM - Channels, Bands, Architecture, Mobility management, Handover detection & Management; GPRS - Architecture, GPRS Interfaces & GPRS Network Protocols.	**8 Hours**
Module-2	**Short-Range Wireless Technologies**: IEEE 802.11 System Architecture, Ad-Hoc & Infrastructural Mode, MAC Frame Format; Bluetooth - Piconet, Scatternet, Protocol stack and Profile; WAP - Architecture, Components, Gateway and Protocol Stack; WML Script - Variables, Control structure and Functions; IMT 2000 Standards - WCDMA & CDMA 2000.	**9 Hours**
Module-3	**Mobile IP & Transport Protocols**: Overview, Requirements, Entities, Agent advertisement and Discovery, Registration, IP Packet delivery, Tunneling and Encapsulation, IPv6, DHCP, ICMP; Mobile Transport Layer - I-TCP, Snooping TCP, M-TCP, T-TCP; WLL - Architecture, Components, Functionalities; Wireless Enterprise Networks.	**8 Hours**
Module-4	**Ad-hoc Networks & VPN**: Introduction, Application & challenges; Routing in Ad-hoc Networks - Types, Reactive (DSR & AODV) & Proactive (DSDV and WRP) protocols; VPN - Features, Remote Access, Site to Site VPN & VPN Protocols; Security Challenges in Mobile Computing.	**9 Hours**
Module-5	**Mobile OS & Applications**: Multimedia content delivery in Mobile network; Mobile OS – Introduction, Android & iOS; Application development for Mobile platforms, Android Studio and Java programming language, 3-tier Architecture for Mobile Computing, Design considerations and Computing through Internet, IoT, Latest trends and Research.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. J. Schiller, ***Mobile Communication***, 2nd *Ed.*, Pearson Education, 2004.
T2. Y-B. Lin, I. Chlamtac, ***Wireless and Mobile Network Architectures***, 1st *Ed.*, Wiley, 2008.
T3. R. Kamal, ***Mobile Computing***, 2nd *Ed.*, Oxford University Press, 2011.

Reference Books:

R1. A. K. Talukder, H. Ahmed, and R. Yavagal, ***Mobile Computing***, 2nd *Ed.*, McGraw Hill, 2017.
R2. V. K. Garg, ***Wireless Communication and Networks***, 2nd *Ed.*, Pearson Education, 2003.
R3. U. Hansmann, L. Merk, M. Nicklous, and T. Stober, ***Principles of Mobile Computing***, 2nd *Ed.*, Springer, 2006.

Online Resources:

1. https://nptel.ac.in/courses/106106147: by Prof. P. Singh and Prof. S. Iyer, IIT Madras
2. https://nptel.ac.in/courses/117104099: by Prof. A. K. Jagannatham, IIT Kanpur
3. https://nptel.ac.in/courses/106106167: by Prof. D. K. Pillai, IIT Madras

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

CO1	Explain wireless and cellular systems, MAC methods, and GSM/GPRS architecture.
CO2	Describe WLAN, Bluetooth, WAP, and IMT-2000 architectures and their key protocols.
CO3	Explain Mobile IP, mobile transport protocols, and WLL architecture and functions.
CO4	Describe MANET routing, VPN mechanisms, and security challenges in mobile networks.
CO5	Assess suitable wireless technologies for designing and developing enterprise applications.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Human Values & Professional Ethics	L-T-P	Credits	Marks
UCR	HS0002		2-0-0	0	100

Objectives	The objective of this course is to enable the students to become aware of professional ethics and universal human values. It will instill moral and social values and loyalty to appreciate the rights of others. This course also provides the basis for deciding whether a particular action is morally good or bad.
Pre-Requisites	Elementary idea on Psychology, sensitivity to professionalism with respect to morality, judgment, and commitment are required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required, and planned interactive sessions.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction to Value Education**: Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations.	**6 Hours**
Module-2	**Harmony in the Human Being**: Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.	**6 Hours**
Module-3	**Harmony in the Family and Society**: Harmony in the Family – Family as the Basic Unit of Human Interaction, Values in Human-to-Human Relationship, 'Trust' – the Foundational Value in Human Relationship, 'Trust Deficit' - the concept and its dimensions and implications, 'Respect' as the Right Evaluation, Understanding Harmony in the Society, Vision for the Universal Human Order.	**6 Hours**
Module-4	**Harmony in the Nature or Existence**: The Four Orders of Nature, Understanding Harmony in the Nature, Interconnectedness, Self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at all Levels, The Holistic Perception of Harmony in Existence.	**4 Hours**
Module-5	**Implications of the Holistic Understanding – A Look at Professional Ethics**: Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.	**6 Hours**
	Total	**28 Hours**

Text Books:

T1. R. R. Gaur, R. Asthana, and G. P. Bagaria, ***A Foundation Course in Human Values and Professional Ethics***, 2nd *Ed.*, Excel Books, 2019.

T2. A. Nagaraj, ***Jeevan Vidya : Ek Parichaya***, Jeevan Vidya Prakashan, 1999.

Reference Books:

R1. A. N. Tripathi, ***Human Values***, 3rd *Ed.*, New Age International Publishers, 2019.
R2. M. K. Gandhi, Translated (from Gujarati) by M. Desai, ***The Story of My Experiments with Truth***, 1st *Ed.*, FingerPrint Publishing, 2009.

Online Resources:

1. http://hvpe1.blogspot.com/2016/06/notes-human-values-and-professional.html
2. https://examupdates.in/professional-ethics-and-human-values
3. http://www.storyofstuff.com
4. https://aktu.ac.in/hvpe/ResourceVideo.aspx

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

CO1	Explain human aspirations and understand the role of value education in engineering.
CO2	Attain living in harmony with self and other human beings with due self-regulation.
CO3	Sincerely evaluate their interactions with their family, friends, and society as a whole.
CO4	Experience living in harmony with nature and realize co-existence at all levels.
CO5	Act professionally with desired levels of ethics for a prosperous society.

Program Outcomes Relevant to the Course:

PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Networks Lab	L-T-P	Credits	Marks
PCR	CS3040		0-0-2	1	100

Objectives	The objective of this course is to implement various computer networking protocols in a high-level programming language and become acquainted with socket programming & network simulator tools.
Pre-Requisites	Knowledge of programming and concepts of computer networks taught in the theory class are required.
Teaching Scheme	Regular laboratory classes conducted under supervision of the teacher. The experiments shall comprise of programming and simulation assignments.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Introduction to Network Hardware and Software, Network Commands like Netstat, Tracert, Ping, Path-ping, Telnet, FTP etc.
2	Basic idea about IPv4 addressing and programming to find the IP address of a machine and Ethernet address.
3	Socket Programming for Echo Client and Echo Server using TCP socket.
4	Socket Programming for Chatting between two Machines using TCP socket.
5	Socket Programming for Echo Client and Echo Server using UDP socket.
6	Socket Programming for communicating between two Machines using UDP socket.
7	Implementation of ARP/RARP Protocols using a programming language.
8	Introduction to Network Simulator.
9	To study various types of connector devices (Router, Hub, Switch, Bridge) and verification of standard network topologies using simulator.
10	Simulate a given network with proper labeling of the devices using simulator.
11	Configure the DNS, DHCP, HTTP, FTP servers using simulator.
12	Configure an email server and establish a Virtual LAN (VLAN) using simulator.
13	Configure static & dynamic routing protocols using simulator.
14	Construct a wireless network and set up communication using simulator.

Text Books:

T1. R. Stevens and S. A Rago, ***Advanced UNIX Programming***, 3rd *Ed.*, Pearson Education, 2013.
T2. L. V. Winkle, ***Hands-On Network Programming with C***, 1st *Ed.*, Packt Publishing, 2019.

Reference Books:

R1. S. Walton, ***LINUX Socket Programming***, 2nd *Ed.*, SAMS Publication, 2007.
R2. M. J. Donahoo and K. L. Calvert, ***TCP/IP Sockets in C : Practical Guide for Programmers***, 2nd *Ed.*, Morgan Kaufmann, 2009.

P.T.O

Online Resources:

1. https://home.iitk.ac.in/~chebrolu/ee673-f06/sockets.pdf: by Prof. K. Chebrolu, IIT Kanpur
2. https://www.cs.cmu.edu/~srini/15-441/S10/lectures/r01-sockets.pdf

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

CO1	Recognize networking devices and basic network commands for Windows & Linux OS.
CO2	Implement TCP/UDP socket-based client-server applications on systems and networks.
CO3	Apply HTTP over TCP/UDP connection with help of a Browser.
CO4	Illustrate the Flow control protocols, MAC and routing protocols.
CO5	Design and analyze a network using a simulation tool.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Organization & Architecture Lab	L-T-P	Credits	Marks
PCR	CS3041		0-0-2	1	100

Objectives	The objective of this course is to provide hands-on experience in computer hardware, 8085 assembly programming, digital logic simulation and memory organization techniques through practical experiments and real-time applications.
Pre-Requisites	Knowledge of computer basics and programming logic is required.
Teaching Scheme	Regular classes with the use of ICT whenever required through demonstration of computer system components and simulation of concepts using Assembly Language and MATLAB.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Study of Computer Components.
2	Study of different types of Motherboards.
3	Assembling & dissembling of a system.
4	Introduction to 8085 Simulator and basic Assembly language programming.
5	Assembly language programming in 8085 simulator using conditional statements.
6	Assembly language programming in 8085 simulator using loop.
7	Introduction to MATLAB.
8	Functions and Control Structures in MATLAB.
9	Script files and Functions in MATLAB.
10	Implementation of basic logic gates and design of Adders.
11	Simulation of Booth Algorithm and Integer division.
12	Simulation of FIFO, LRU and Optimal Page Replacement Algorithms
13	Simulation of Direct mapping, Associative mapping and Set-associative mapping.

Text Books:

T1. N. K. Srinath, ***8085 Microprocessor: Programming and Interfacing***, 1st *Ed.*, PHI Learning, 2005.
T2. R. Pratap, ***Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers***, 2nd *Ed.*, Oxford University Press, 2010.

Reference Books:

R1. T. A. Davis, ***MATLAB Primer***, 8th *Ed.*, CRC Press, 2017.
R2. R. Garg, ***Programming with Assembly Language***, 1st *Ed.*, Laxmi Publications, 2019.

Online Resources:

1. https://nptel.ac.in/courses/106102157: by Prof. S. R. Sarangi, IIT Delhi
2. https://nptel.ac.in/courses/111102137: Prof. M. Mehra and Prof. V. K. Aggarwal, IIT Delhi

P.T.O

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

CO1	Identify components of a digital computer and demonstrate its assembly and disassembly.
CO2	Develop assembly programs and understand instruction execution using the 8085 simulator.
CO3	Write, test, and debug programs in MATLAB using different control structures and functions.
CO4	Implement the logic gates for binary arithmetic operations using MATLAB.
CO5	Analyze different cache memory mapping techniques and replacement policies.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Mobile Application Development Lab	L-T-P	Credits	Marks
PCR	CS3042		0-0-4	2	100

Objectives	The objective of this course is to learn the fundamental concepts of mobile applications and to develop & deploy Android applications using various developer tools and languages.
Pre-Requisites	Knowledge of Java programming language is required.
Teaching Scheme	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 / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1 - 2	Develop an application that uses GUI components - Font and Colours.
3 - 4	Develop an application that uses Layout Managers and event listeners.
5 - 6	Write an application that draws basic graphical primitives on the screen.
7 - 8	Develop an application that makes use of databases.
9 - 10	Develop an application that makes use of Notification Manager.
11 - 12	Implement an application that uses multi-threading.
13 - 14	Develop a native application that uses GPS location information.
15 - 16	Implement an application that writes data to the SD card.
17 - 18	Implement an application that creates an alert upon receiving a message.
19 - 20	Write a mobile application that makes use of RSS feed.
21 - 22	Develop a mobile application to send an email.
23 - 28	Mini Project - develop a complete mobile application.

Text Books:

T1. K. A. Khan and M. S. Manisha, ***Android Programming***, 1st *Ed.*, Nirali Prakhashan, 2019.
T2. J. Horton, ***Android Programming for Beginners***, 3rd *Ed.*, Packt Publishers, 2021.

Reference Books:

R1. A. Bajaj, ***Android Applications Development: Practical Approach***, 1st *Ed.*, Rigi Publication, 2025.
R2. M. Burton, ***Android App Development for Dummies***, 3rd *Ed.*, Wiley India, 2015.
R3. D. Griffiths and D. Griffiths, ***Head First Android Development: A Brain-Friendly Guide***, 2nd *Ed.*, Shroff/O'Reilly, 2017.

Online Resources:

1. https://developer.android.com/courses
2. https://www.geeksforgeeks.org/android/android-tutorial/
3. https://www.tutorialspoint.com/android/index.htm

P.T.O

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

CO1	Setup and configure Android environment and development tools.
CO2	Develop rich user Interfaces by using layouts and controls.
CO3	Utilize various UI components for android application development.
CO4	Develop Android applications using database, email, notifications etc.
CO5	Publish a complete Android application and test & debug the same.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Soft Computing	L-T-P	Credits	Marks
PCR	CS4001		3-0-0	3	100

Objectives	The objective of this course is to learn how to solve real-world problems using various soft computing techniques such as Fuzzy Logic, Genetic Algorithm (GA), Artificial Neural Networks (ANN), and hybridization when necessary.
Pre-Requisites	Knowledge of Linear Algebra, Data Structures, and Algorithm Design is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on problem solving.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Fuzzy Logic**: Definition and Terminology of Fuzzy Set, Set Theoretic Operations, T-Norm, T-Conorm, Membership Function Formulation and Parameterization, Extension Principle, Fuzzy Relations, Linguistic Variables, Fuzzy If-Then Rules, Compositional Rule of Inference, Fuzzy Reasoning, Fuzzy Inference Systems, Defuzzification, Mamdani, Sugeno, and Tsukamoto Fuzzy Models.	**10 Hours**
Module-2	**Genetic Algorithm**: Introduction, Working Cycle, Binary Coded GA, GA-Parameter Setting, Constraint Handling, Advantages and Disadvantages; Specialized GAs, Real Coded GA.	**8 Hours**
Module-3	**Neural Network-I**: Introduction, Models of Neuron, Network Architecture, Knowledge Representation; Learning Process, Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive Learning, Boltzmann Learning, Learning with a Teacher, Learning without a Teacher; Single Layered Learning – Least Mean Square Algorithm, Perceptron, Perceptron Convergence Algorithm.	**10 Hours**
Module-4	**Neural Network-II**: Multi-Layer Perceptron, Back-Propagation Algorithm, XOR gate Problem, Heuristics for Back-Propagation Algorithm; Self-Organizing Maps – Two Basic Feature Mapping Models, SOM Algorithm.	**8 Hours**
Module-5	**Hybrid Systems**: Combination of GA With Fuzzy Logic or Neural Networks, Combination of Neural Network and Fuzzy Logic.	**6 Hours**
	Total	**42 Hours**

Text Books:

T1. S. N. Sivanandam and S. N. Deepa, ***Principles of Soft Computing***, 3rd *Ed.*, Wiley India, 2023.

T2. J. S. R. Jang, C. T. Sun, and E. Mizutani, ***Neuro-Fuzzy & Soft Computing - A Computational Approach to Learning and Machine Intelligence***, 1st *Ed.*, Pearson Education, 2026.

T3. D. K. Pratihar, ***Soft Computing***, 2nd *Revised Ed.*, Narosa Publishing House, 2018.

Reference Books:

R1. S. Haykin, ***Neural Networks: A Comprehensive Foundation***, 2nd *Ed.*, Pearson Education, 2006.

R2. T. Munakata, ***Fundamentals of the New Artificial Intelligence - Neural, Evolutionary, Fuzzy and More***, 2nd *Ed.*, Springer, 2014.

R3. F. O. Karray and C. De Silva, ***Soft Computing and Intelligent System Design - Theory, Tools and Applications***, 1st *Ed.*, Pearson Education, 2009.

Online Resources:

1. https://nptel.ac.in/courses/111105614: by Prof. S. Kundu, IIT-ISM Dhanbad
2. https://nptel.ac.in/courses/117105084: by Prof. S. Sengupta, IIT Kharagpur
3. https://nptel.ac.in/courses/127105006: by Prof. D. K. Pratihar, IIT Kharagpur

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

CO1	Design real-life automation systems using fuzzy logic and inference methods.
CO2	Apply the concepts of GA to solve engineering optimization problems.
CO3	Implement ANNs to solve real-life engineering and societal problems.
CO4	Explore advanced ANN and self-organizing maps for engineering solutions.
CO5	Recognize hybridization needs and develop models for complex problems.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Internet of Things	L-T-P	Credits	Marks
PCR	CS4002		3-0-0	3	100

Objectives	The objective of this course is to learn the concepts, technologies, design principles, communication protocols, challenges, application areas and develop IoT applications for the real world.
Pre-Requisites	Basic knowledge of programming, computer networks, sensors, micro-processor, and micro-controllers is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on examples, case-studies, and latest trends.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Fundamentals & Architecture**: Definition, Characteristics, Physical Design – Generic Block Diagram, Protocols; Logical Design – Functional Blocks, Communication Models and APIs; Sensors and Actuators, Deployment Levels, Application Domains, Privacy and Security Concerns.	**10 Hours**
Module-2	**Network & Protocols**: OSI Reference Model and Its Relevance to IoT, Simple Network Management Protocol (SNMP), NETCONF and YANG.	**8 Hours**
Module-3	**Devices & Enabling Technologies**: Zigbee, Bluetooth, Bluetooth Low Energy, Wi-Fi, RFID; Role of Cloud Computing in IoT, Use of Data Analytics, Big Data and Visualization in IoT.	**8 Hours**
Module-4	**Platforms, M2M & System Design**: M2M Communication, IoT vs M2M, Software Defined Networking, Network Function Virtualization, IoT Design Methodology, Resource Management and Data Synchronization, Open IoT Platforms and Stacks, Web of Things.	**9 Hours**
Module-5	**Applications & Case Studies**: Home Automation, Smart Grid, Agriculture, Healthcare, Smart Industry, Environmental Monitoring, Smart Cities.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. A. Bahga and V. Madisetti, ***Internet of Things: A Hands-on Approach***, 1st *Ed.*, University Press, 2018.
T2. O. Hersent, D. Boswarthick, and O. Elloumi, ***The Internet of Things: Key Applications and Protocols***, Student Edition, John Wiley & Sons, 2016.

Reference Books:

R1. R. Kamal, ***Internet of Things: Architecture and Design Principles***, 1st *Ed.*, McGraw-Hill, 2017.
R2. D. Uckelmann, M. Harrison, and F. Michahelles, ***Architecting the Internet of Things***, 1st *Ed.*, Springer, 2011.
R3. R. Buyya and A. V. Dastjerdi, ***Internet of Things: Principles and Paradigms***, 1st *Ed.*, Elsevier, 2016.

Online Resources:

1. https://nptel.ac.in/courses/106105166/: by Prof. S. Misra, IIT Kharagpur
2. https://nptel.ac.in/courses/108108098/: by Prof. T. V. Prabhakar, IISc Bangalore

P.T.O

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

CO1	Describe basic concepts of IoT, its architecture, and system design.
CO2	Analyze and apply IoT communication models, architectures, and protocols effectively.
CO3	Identify and evaluate IoT devices, integrate with cloud, and big data platforms.
CO4	Analyze and design IoT systems using M2M, SDN, NFV, and Web of Things.
CO5	Envisage and compare real-world applications of IoT in different domains.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	OOAD & Patterns Using UML	L-T-P	Credits	Marks
PCR	CS4003		3-0-0	3	100

Objectives	The objective of this course is to learn Object Oriented Analysis and Design (OOAD) including UML models and to effectively use Object Oriented technologies for software system modeling as part of the software development process to solve real world problems.
Pre-Requisites	Understanding of Software Engineering including SDLC, Object Oriented concepts, and familiarity with Modeling techniques is required.
Teaching Scheme	Regular classroom lectures with the use of ICT tools as and when required; sessions are planned to use real-world case studies of contemporary Object Oriented Software projects in an interactive environment,

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to Object Oriented Software development process and OOAD; UML models - Unified Process & evolution of UML models, Five types of Views, Nine types of models; Use Case model - Modeling of Central/User's view of the system through Use Case models, Components of Use Case model, Detail level Use case modelling by Factoring of Use cases through include, extend, and generalization relationships, Use Case packaging.	**9 Hours**
Module-2	Structural View of the system - Class & Object UML models; Domain model and subsequent refinements, identifying physical & conceptual classes, Determining Class contents (attributes & methods), Relationships between Classes (Associations, Aggregation, Composition, Dependancy, and Inheritance), Building class hierarchies using bottom-up approach.	**8 Hours**
Module-3	Behavioral view of the system - Interaction models – Purpose, Components, and Guidelines for building (i) Sequence model, (ii) Collaboration model, (iii) Activity model, and (iv) State-chart model.	**9 Hours**
Module-4	Implementation view of the system - Purpose, Components, and Guidelines for building Component model; Environmental view of the system - Purpose, Components, and Guidelines for building Deployment model.	**8 Hours**
Module-5	Advanced topics - Model-Driven Development (MDD), Automated design and Code generation techniques; Customization of OOAD and UML models for contemporary Agile environments (just-enough modeling), Case Study and Industry examples.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. C. Larman, ***Applying UML and Patterns: An Introduction to Object Oriented Analysis and Design and Iterative Development***, 3rd *Ed.*, Pearson Education, 2005.

T2. M. Blaha and J. Rumbaugh, ***Object-Oriented Modeling and Design with UML***, 2nd *Ed.*, Pearson Education, 2005.

Reference Books:

R1. G. Booch, M. W. Engel, K. A. Houston, R. A. Maksimchuk, B. J. Young, and J. Conallen, ***Object-Oriented Analysis and Design with Applications***, 3rd *Ed.*, Pearson Education, 2009.

R2. E. Gamma, R. Helm, R. Johnson, and J. Vlissides, ***Design Patterns: Elements of Reusable Object-oriented Software***, Pearson Education, 2004.

Online Resources:

1. https://nptel.ac.in/courses/106105224: by Prof. R. Mall, IIT Kharagpur
2. https://nptel.ac.in/courses/106105153: by Prof. P. Das and others, IIT Kharagpur

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

CO1	Explain OOAD process and UML views and describe use case modeling concepts.
CO2	Design structural UML models by identifying classes, attributes, methods, and relationships.
CO3	Analyze and design system behavior using UML interaction, activity, and state models.
CO4	Model component and deployment views to support implementation and system environment.
CO5	Apply MDD, code generation, and Agile-based UML modeling using industrial case studies.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Advanced Java Programming	L-T-P	Credits	Marks
PCR	CS4004		3-1-0	4	100

Objectives	The objective of this course is to learn advanced features of the Java programming language, various frameworks in J2EE for rapid development, and apply these to develop enterprise applications.
Pre-Requisites	Knowledge of object-oriented programming using Java is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with a focus on programming activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Web Fundamentals & Java Collections**: Interfaces vs Implementation, Object Class Contract, Wrapper Classes & Autoboxing, Exception handling, Client-Server Architecture, Web Server vs Application Server, HTTP Protocol – Request/Response Cycle, Status Codes, GET and POST Method; Generics – Generic Classes and Methods, Type Safety; Collections – ArrayList, LinkedList, HashMap, HashSet, Iterators, and Enhanced for-loop.	**12 Hours**
Module-2	**Database Connectivity**: JDBC Architecture, Drivers, SQL package, Connection, Statement, Prepared Statement, Result Set, SQL Injection, Performing CRUD operations, Exception Handling in JDBC, Transaction Processing, Metadata, Introduction to the DAO.	**10 Hours**
Module-3	**Servlets**: Introduction, Servlet Architecture, Environment Setup, Web Container, Lifecycle, Form Data processing, Client HTTP Request, Server HTTP Response, HTTP Status Codes, Exception Handling; Advanced Features of Servlets – Handling Cookies, Session Tracking, URL rewriting, Database access, Date handling, Page redirection, Debugging, Internationalization.	**12 Hours**
Module-4	**JSP & JSTL**: Advantages of JSP over Servlet, Lifecycle of a JSP page, JSP API, Scriptlet tag, Implicit objects, Directives, Exception handling, Action tags, Expression Language (EL); Advanced Features of JSP: Session Tracking, JSTL, Custom Tags, CRUD operations.	**10 Hours**
Module-5	**Spring Ecosystem**: Problem with JDBC, Spring Core, IoC, DI, Spring Container, Bean Scopes & Lifecycle, Spring Boot Architecture, JPA Entities & Basic Annotations, ID Generation Strategies, Association Mappings, Fetch Types & Cascading, Spring Data Repositories, Derived Query Methods, Custom JPQL & Native Queries, Pagination & Sorting, Transaction Management, Spring MVC Integration.	**12 Hours**
	Total	**42 Hours**

Text Books:

T1. J. Murach and M. Urban, ***Murach's Java Servlets and JSP***, 3rd *Ed.*, Murach & Associates, 2014.
T2. H. Schildt, ***Java: The Complete Reference***, 12th *Ed.*, McGraw-Hill Education, 2021.
T3. C. Walls, ***Spring in Action***, 6th *Ed.*, Manning Publications, 2022.

Reference Books:

R1. B. Basham, K. Sierra, and B. Bates, ***Head First Servlets and JSP***, 2nd *Ed.*, O'Reilly Media, 2008.
R2. C. S. Horstmann, ***Core Java Volume II – Advanced Features***, 14th *Ed.*, Pearson Education, 2025.

Online Resources:

1. https://nptel.ac.in/courses/106105084: by Prof. I. Sengupta, IIT Kharagpur
2. https://nptel.ac.in/courses/106105191: by Prof. D. Samanta, IIT Kharagpur
3. https://docs.spring.io/spring-framework/reference/
4. https://www.tutorialspoint.com/spring_boot_jpa/index.htm

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

CO1	Apply Java Collections and generics with HTTP protocol to develop foundational web apps.
CO2	Apply JDBC for secure CRUD operations and transaction management using the JDBC API.
CO3	Develop Servlet-based web apps with session tracking, cookies, and database connectivity.
CO4	Construct dynamic web views using JSP, EL, and JSTL, incorporating the MVC design pattern.
CO5	Construct Spring Boot apps using IoC, JPA mappings, and Spring Data repositories efficiently.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Natural Language Processing	L-T-P	Credits	Marks
PEL	CS4013		3-0-0	3	100

Objectives	The objective of this course is to study fundamentals, algorithms, and techniques to enable processing of natural languages by computers in order to design different human-computer interactive systems.
Pre-Requisites	Knowledge on grammar rules, statistics, regular expressions, and automata theory is required.
Teaching Scheme	Regular classroom lectures with use of ICT as required, sessions are planned to be interactive with focus on examples, problem solving, and latest advances.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction, Applications, Phases of NLP, Issues and processing complexities, Language modeling, Grammar-based and Statistical language models, n-gram model, Smoothing techniques.	**8 Hours**
Module-2	Word level analysis, Regular expressions, Finite state automata, Finite state transducers, Text pre-processing, Tokenization, Normalization, Stop word removal, Stemming, Lemmatization, Part-of-speech tagging, Named-entity recognition, Spelling error detection and correction.	**8 Hours**
Module-3	Syntactic analysis, Top-down & bottom-up parsing, Earley, CYK, and Probabilistic parsing, Semantic analysis, Meaning representation languages, Dependency parsing, Word sense disambiguation, Discourse and pragmatic analysis.	**8 Hours**
Module-4	Word representations - BoW, TF-IDF, Word embeddings: Word2Vec (CBOW, Skip-Gram), Word senses and Contextual embeddings, Word similarity measures, ML for NLP, Sentiment analysis, Evaluation metrics, Large language models.	**9 Hours**
Module-5	Machine translation, Information retrieval, Information extraction, Text summarization, Question answering system, Natural language generation, Chatbots & dialogue systems, other advanced applications of NLP.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. D. Jurafsky and J. H. Martin, ***Speech and Language Processing - An introduction to Language Processing, Computational Linguistics, and Speech Recognition***, 2nd *Ed.*, Pearson Education, 2013.
T2. T. Siddiqui and U. S. Tiwary, ***Natural language Processing and Information Retrieval***, 1st *Ed.*, Oxford University Press, 2008.

Reference Books:

R1. J. Allen, ***Natural Language Understanding***, 2nd *Ed.*, Pearson Education, 2008.
R2. C. D. Manning and H. Schütze, ***Foundations of Statistical Natural Language Processing***, 2nd *Ed.*, MIT Press, 2000.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/106101007/: by Prof. P. Bhattacharyya, IIT Bombay
2. https://nptel.ac.in/courses/106105158/: by Prof. P. Goyal, IIT Kharagpur
3. https://nlp.stanford.edu/fsnlp/
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-863j-natural-language-and-the-computer-representation-of-knowledge-spring-2003/lecture-notes/

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

CO1	Explain the fundamental concepts and language models for natural language processing.
CO2	Apply word-level analysis techniques to prepare raw text for analysis.
CO3	Perform syntactic, semantic and discourse level analysis of natural language text.
CO4	Design various statistical and machine learning models for NLP tasks.
CO5	Implement applications of NLP in human-computer interactive systems.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Theory of Computation	L-T-P	Credits	Marks
PEL	CS4014		3-0-0	3	100

Objectives	The objective of this course to study the mathematical foundations of computation including Automata theory, formal languages and grammars, concept of algorithms, decidability, complexity, and computability.
Pre-Requisites	Basic knowledge of discrete mathematics is required.
Teaching Scheme	Regular classroom lectures with use of ICT as required; sessions are planned to be interactive with focus on problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Automata theory, Computability theory, Complexity theory; Mathematical Notations & Terminology - Alphabet, String, Languages and Operations on strings; Finite Automata (Deterministic) - Formal definition, Transition function, Extended transition function, Language and Design of DFA; Finite Automata (Non-deterministic) - Formal definition, Language of NFA, Equivalence of DFA & NFA; NFA with Epsilon transition - Eliminating ϵ-transitions from NFA, Conversion from ϵ-NFA to DFA, Minimization of DFA.	**9 Hours**
Module-2	**Regular Expressions**: Operators and their precedence, Building regular expressions, DFA to Regular expressions, Regular expressions to DFA, Arden's theorem, Pumping Lemma for Regular languages, Closure properties of Regular languages. Moore and Mealy machines.	**8 Hours**
Module-3	**Grammars**: Definition, Derivation of string, Left & Right linear grammars, Regular grammars; Context free grammars - Definition, Derivation of string, Language of CFG, Parse tree, Ambiguity in grammar, Elimination of ambiguity; Normal forms of CFG: Chomsky & Greibach normal forms, Converting CFG to CNF & GNF, Cook, Younger, Kasami algorithm; Closure properties of context free languages.	**9 Hours**
Module-4	**Push Down Automata**: Basic model, Components, Moves of a PDA, ID of a PDA, Design of a PDA, PDA to CFG and CFG to PDA conversion; Pumping Lemma for CFL; Turing Machines - Model, Components, ID of TM, Design of a TM, Variation of TM model, Recursively enumerable languages, Universal Turing machine and un-decidable problems.	**8 Hours**
Module-5	**Turing Decidable & Recognizable Languages**: Church Turing hypothesis, Recursive and recursively enumerable sets, Chomsky's hierarchy of languages; Un-decidability of Post correspondence problem, Linear bounded Automata and Context sensitive languages; Primitive recursive functions: μ-Recursive functions, Ackermann's function, Turing computable functions, Cantor & Gödel numbering; NP Completeness - P, NP, NP complete and NP Hard problems.	**8 Hours**
	Total	**42 Hours**

P.T.O

Text Books:

T1. J. E. Hopcroft, R. Motwani, and J. D. Ullman, ***Introduction to Automata Theory, Languages and Computation***, 3rd *Ed.*, Pearson Education, 2007.
T2. P. Linz, ***An Introduction to Formal Languages and Automata***, 4th *Ed.*, Jones & Bartlett Learning, 2006.

Reference Books:

R1. M. Sipser, ***Introduction to the Theory of Computation***, 3rd *Ed.*, Cengage Learning, 2012.
R2. J. C. Martin, ***Introduction to Languages and the Theory of Computation***, 4th *Ed.*, Tata McGraw-Hill, 2010.
R3. K. L. P. Mishra, and N. Chandrasekaran, ***Theory of Computer Science: Automata, Languages and Computation***, 3rd *Ed.*, PHI, 2012.

Online Resources:

1. https://nptel.ac.in/courses/111/103/111103016/: by Dr. K.V. Krishna and Dr. D. Goswami, IIT Guwahati
2. https://nptel.ac.in/courses/106/106/106106049/: by Prof. K. Krithivasan, IIT Madras
3. https://nptel.ac.in/courses/106/105/106105196/: by Prof. S. Mukhopadhyay, IIT Kharagpur
4. https://www.ics.uci.edu/~goodrich/teach/cs162/notes/: by Prof. M. T. Goodrich, University of California, Irvine, USA

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

CO1	Develop mathematical models with DFA, NFA for regular languages for real life applications.
CO2	Design grammar & PDA for context free languages and demonstrate their properties.
CO3	Construct Turing machines for context sensitive and unrestricted languages.
CO4	Describe the Chomsky hierarchy of formal languages and grammar.
CO5	Explain decidability, recursive enumerability, and P, NP or NPC class of languages.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Realtime Systems	L-T-P	Credits	Marks
PEL	CS4015		3-0-0	3	100

Objectives	The objective of this course is to study the concepts and approaches in the design and analysis of real-time systems including real-time operating systems, communication, and databases.
Pre-Requisites	Knowledge of operating systems, computer networks, and database management systems is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on examples and problem-solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Concepts, Applications, Characteristics, Basic model, Safety and reliability, Types of Realtime tasks, Timing constraints and its modelling.	**8 Hours**
Module-2	**Realtime Task Scheduling**: Concepts & terminologies, Types of realtime tasks and their characteristics, Classification of realtime task scheduling algorithms, Clock-driven, Event driven, EDF, RMA & Hybrid scheduling; Scheduling Realtime Tasks in Multiprocessor and Distributed Systems: Dynamic allocation and fault-tolerant scheduling of tasks, Clocks in distributed realtime systems, Centralized and Distributed clock synchronization.	**10 Hours**
Module-3	**Resource Sharing & Dependencies**: Resource sharing among Realtime tasks, Priority inversion, Priority Inversion Protocol (PIP), Highest Locker Protocol (HLP), Priority Ceiling Protocol (PCP), Different types of priority inversions under PCP, Important features of PCP, Issues in using resource sharing protocol and Handling task dependencies.	**10 Hours**
Module-4	**Realtime Operating Systems**: Time services, Features, Unix and Windows NT as RTOS, POSIX, A survey of contemporary RTOS (Windows CE, RT-Linux, VxWorks, QNX, INTEGRITY).	**7 Hours**
Module-5	**Realtime Communication & Databases**: Concepts, Applications and examples of Realtime communication, Soft and hard Realtime communication in a LAN; Realtime Databases: Concepts, Examples, and Applications of Realtime databases, Characteristics of temporal data, Concurrency control, Commercial Realtime databases.	**7 Hours**
	Total	**42 Hours**

Text Books:

T1. R. Mall, ***Real-Time Systems***, 2nd *Ed.*, Pearson Education, 2010.

Reference Books:

R1. J. W. S. Liu, ***Real-Time Systems***, 1st *Ed.*, Pearson Education, 2002.
R2. C. M. Krishna and K. G. Shin, ***Real-Time Systems***, 1st *Ed.*, McGraw-Hill Education, 2017.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/106105036/: by Prof. R. Mall, IIT Kharagpur
2. https://nptel.ac.in/courses/106105172/: by Prof. R. Mall, IIT Kharagpur

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

CO1	Describe characteristics & applications of real-time systems and their timing constraints.
CO2	Explain realtime task scheduling algorithms and analyze their schedulability criteria.
CO3	Explore the PIP, HLP & PCP protocols for sharing critical resources among realtime tasks.
CO4	Explore realtime operating systems and evaluate their suitability for practical applications.
CO5	Apply the concepts of realtime communication and realtime databases.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Soft Computing Lab	L-T-P	Credits	Marks
PCR	CS4005		0-0-2	1	100

Objectives	The objective of this course is to get hands on experience on key soft computing algorithms using Python programming applied on real-life problems.
Pre-Requisites	Knowledge of python programming and concepts of soft computing algorithms taught in the theory classes is required.
Teaching Scheme	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 / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Write functions to generate parameterized fuzzy membership functions, apply them for following parameter values: Triangular, Trapezoidal, Gaussian, Generalized Bell and Sigmoidal MFs.
2	Write functions to implement fuzzy operations on continuous & discrete membership functions and apply them for different parameter values.
3	Write functions to implement T-norms fuzzy operations on continuous membership functions and apply them for following parameter values: Minimum and Algebraic, Bounded, Drastic products.
4	Write a function to compute the max-min composition of two fuzzy relations.
5	Write a function to compute the max-product composition of two fuzzy relations.
6	Demonstrate the effect of contrast intensification on a fuzzy membership function.
7	Write functions for implementing cylindrical extension of a 1D membership function and projection of a 2D membership function. Demonstrate the results visually.
8	Write programs for selection of chromosome for pool using roulette wheel, rank selection, and tournament selection approaches.
9	Write programs to solve unconstraint optimization problems using Genetic Algorithm (GA).
10	Plot the graphs of different activation functions.
11	Implement AND, OR, XOR gates using single layer Perceptron neural network.
12	Design a classifier using multi-layer Back-propagation neural network to classify on a dataset.

Text Books:

T1. D. K. Pratihar, ***Soft Computing***, 2nd *Revised Ed.* Edition, Narosa Publishing, 2018.
T2. J. S. R. Jang, C. T. Sun, and E. Mizutani, ***Neuro Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence***, 1st *Ed.*, Pearson Education, 2026.

Reference Books:

R1. T. J. Ross, ***Fuzzy Logic with Engineering Applications***, 4th *Ed.*, Wiley, 2020.
R2. M. Negnevitsky, ***Artificial Intelligence: A Guide to Intelligent Systems***, 3rd *Ed.*, Pearson Education, 2020.
R3. T. Segaran, ***Programming Collective Intelligence***, 1st *Ed.*, O'Reilly Media, 2007.

Online Resources:

1. https://nptel.ac.in/courses/111105614: by Prof. S. Kundu, IIT-ISM Dhanbad
2. https://nptel.ac.in/courses/117105084: by Prof. S. Sengupta, IIT Kharagpur
3. https://nptel.ac.in/courses/127105006: by Prof. D. K. Pratihar, IIT Kharagpur

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

CO1	Describe the concepts of fuzzy logic and implement fuzzy membership functions and operations.
CO2	Apply fuzzy relations and transformations in practical systems.
CO3	Implement GA for optimization problems with and without constraints.
CO4	Execute single and multi-layer neural networks for basic logic operations and classification.
CO5	Design and evaluate a multilayer neural network classifier using real-world datasets.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Internet of Things Lab	L-T-P	Credits	Marks
PCR	CS4006		0-0-2	1	100

Objectives	The objective of this laboratory course is to design solutions for different real-life use-cases through IoT-based hardware configuration and programming.
Pre-Requisites	Basic knowledge of computer networks, sensor network, micro-processor, micro-controllers, and programming is required for this course.
Teaching Scheme	Regular Laboratory classes with the use of ICT whenever required; experiments shall comprise of developing end-to-end IoT systems for specific applications.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Installation and configuration of Raspberry Pi, blinking LED program, creating different LED patterns using loops and functions.
1	Platform familiarization and GPIO basics: Study of architecture, operating system, and pin diagram of Raspberry Pi.
2	Digital output control and logic sequencing: Implementation of multiple LED interfacing to generate different light patterns.
3	System-level logic design: Design and simulation of a Traffic Light Control System using RGB LEDs.
4	Actuator control and real-world relevance: Interfacing of relay module and implementation of Pulse Width Modulation (PWM) for control of electrical loads.
5	Human–machine interface and data display: Interfacing of an LCD display using I^2C module for data visualization.
6	Introduction to digital sensors: Interfacing and analysis of Infrared (IR) and Passive Infrared (PIR) sensors for motion and object detection with display of output on LCD.
7	Introduction to Analog sensors: Interfacing of DHT11 Temperature–Humidity sensor for environmental parameter monitoring and displaying on LCD.
8	Multi-sensor data acquisition: Monitoring of environmental parameters using Rain, Soil Moisture, Flame, and Smoke Sensors.
9	Cloud concepts and dashboards: Study of Adafruit cloud platform and establishing connectivity with IoT nodes.
10	End-to-end IoT application: Obstacle detection and distance measurement using Ultrasonic sensor integrated with Adafruit cloud.
11	Mini Project – Phase I: Problem Identification and System Design.
12	Mini Project – Phase II: Implementation and Testing of IoT-Based Application.
13 - 14	Mini Project – Phase III: Final Demonstration and Documentation.

Text Books:

T1. A. Bahga and V. Madisetti, ***Internet of Things: A Hands-on Approach***, —edn1, University Press, 2018.
T2. O. Hersent, D. Boswarthick, and O. Elloumi, ***The Internet of Things: Key Applications and Protocols***, Student Edition, Wiley India, 2016.

Reference Books:

R1. D. Uckelmann, M. Harrison, and F. Michahelles, ***Architecting the Internet of Things***, —edn1, Springer, 2011.
R2. R. Buyya and A. V. Dastjerdi, ***Internet of Things: Principles and Paradigms***, 1st *Ed.*, Elsevier, 2016.

Online Resources:

1. https://nptel.ac.in/courses/106105166: by Prof. S. Misra, IIT Kharagpur
2. https://nptel.ac.in/courses/108108179: by Prof. T. V. Prabhakar, IISc Bangalore

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

CO1	Describe basic concepts of IoT, its architecture and system design.
CO2	Analyze and apply IoT communication models, architectures, and protocols effectively.
CO3	Identify and evaluate IoT devices, integrate with cloud and big data platforms.
CO4	Analyze and design IoT systems using M2M, SDN, NFV, and Web of Things.
CO5	Envisage and compare real-world applications of IoT in different domains.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	OOAD & Patterns Using UML Lab	L-T-P	Credits	Marks
PCR	CS4007		0-0-2	1	100

Objectives	The objective of this course is to learn Object Oriented software analysis and design through key UML models and to effectively use object oriented approaches and modeling techniques to build software products in real world environment.
Pre-Requisites	Understanding of Software Engineering including SDLC, Object Oriented concepts, and familiarity with Modeling techniques is required.
Teaching Scheme	Regular classroom lectures with the use of ICT tools as and when required; sessions are planned to be interactive, discuss case studies of real-world object-oriented systems.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Selection of OO Software projects to be built during the course.
2	Requirement gathering, analysis for the selected projects.
3-4	Specification writing for the selected projects.
5	Build the central view through Use Case model of the selected projects.
6	Identify the physical and conceptual classes from the requirement specification and develop the Domain Models.
7	Build the Class UML structural models. Find the attributes & operations of each Class. Identify the relationships (five types) between the Classes.
8	For each high-level use cases, create the interaction models through UML Sequence and Collaboration models.
9	Create the next level interaction diagrams through State Chart models.
10	Create the next level interaction diagrams through Activity models.
11	Create the next level interaction diagrams through State Chart and Activity models.
12-13	Draw Component and Deployment models to represent physical implementation.
14	Presentation of component and deployment models, assessment & viva-voce.

Text Books:

T1. C. Larman, ***Applying UML and Patterns: An Introduction to Object Oriented Analysis and Design and Iterative Development***, 3rd *Ed.*, Pearson Education, 2005.

T2. M. Blaha and J. Rumbaugh, ***Object-Oriented Modeling and Design with UML***, 2nd *Ed.*, Pearson Education, 2005.

Reference Books:

R1. G. Booch, M. W. Engel, K. A. Houston, R. A. Maksimchuk, B. J. Young, and J. Conallen, ***Object-Oriented Analysis and Design with Applications***, 3rd *Ed.*, Pearson Education, 2009.

R2. E. Gamma, R. Helm, R. Johnson, and J. Vlissides, ***Design Patterns: Elements of Reusable Object-oriented Software***, Pearson Education, 2004.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/106105224: by Prof. R. Mall, IIT Kharagpur
2. https://nptel.ac.in/courses/106105153: by Prof. P. Das and others, IIT Kharagpur

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

CO1	Gather and analyze the requirements of an appropriate OO system and create the Specification.
CO2	Create Domain and Use Case UML models of the selected system.
CO3	Implement Class and Object UML models depicting the structural view of the system.
CO4	Build Interaction UML models depicting the behavioral view of the system.
CO5	Create Component & Deployment UML models along with some advanced features of OOAD.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Advanced Java Programming Lab	L-T-P	Credits	Marks
PCR	CS4008		0-0-4	2	100

Objectives	The objective of this laboratory course is to provide practical hands-on experience in developing dynamic web applications and to build database-driven web applications using the MVC architecture.
Pre-Requisites	Knowledge of Core Java, SQL and Web Technologies is required.
Teaching Scheme	Regular laboratory classes conducted under the supervision of the teacher. The experiments shall comprise of programming assignments involving Database connectivity, Server-side programming, and Project development.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Generics & ArrayList: Creating generic classes; Implementing arraylist to store and manipulate custom objects (e.g., Student records).
2	LinkedList & Iterators: Differences between array and linked structures; Traversing collections using Iterator and listIterator.
3	Set Interface: Working with HashSet to handle unique data; Understanding hashCode() and equals() implementation.
4	Map Interface: Implementation of HashMap and TreeMap to store key-value pairs; Iterating over keys and values separately.
5	JDBC Setup & Connection: Installation of Database (MySQL/PostgreSQL); Setting up Classpath/Dependency; Establishing a connection using DriverManager.
6	JDBC Statement (Read): Writing a program to retrieve data from the database using the statement interface and processing the resultSet.
7	JDBC Statement (Write): Performing Insert and Update operations using static SQL statements; Handling SQL Exceptions.
8	JDBC PreparedStatement: Performing secure CRUD operations to prevent SQL injection; parameterized queries.
9	JDBC Delete & Search: Implementing search functionality and deletion of records based on ID using PreparedStatement.
10	DAO Pattern: Refactoring JDBC code into a data Access Object (DAO) pattern to separate database logic from business logic.
11	Web Server Configuration: Installation and Directory structure of Apache Tomcat; Understanding web.xml; Creating a “Hello World” Servlet.
12	Servlet Lifecycle: Implementing init(), service(), and destroy() methods to understand the lifecycle of a servlet.
13	Handling Client Requests: Creating an HTML form; processing form data in Servlet using doGet vs doPost.
14	Request Dispatcher: Implementing navigation between Servlets using forward() and include(); passing data between resources.

Cont’d. . .

Experiment-#	Assignment/Experiment
15	Response Redirection: Understanding sendRedirect(); Difference between Forward and Redirect.
16	State Management (Cookies): Creating, Reading, and Deleting Cookies to store user preferences.
17	State Management (Session): Implementing Login/Logout functionality using HttpSession; Session timeout and Invalidation.
18	JSP Basics: Introduction to JSP; Scripting elements (Scriptlet, Expression, Declaration); converting a Servlet to JSP.
19	JSP Implicit Objects: Working with request, response, session, and application objects inside JSP without declaration.
20	Expression Language (EL): Accessing scoped variables and bean properties using EL $ syntax to avoid Java code in Views.
21	JSTL Core Tags: Setup JSTL library; Using <c:out>, <c:if>, <c:choose> for conditional display in JSP.
22	JSTL Iteration: Using <c:forEach> to display Lists/Tables of data retrieved from the database.
23	MVC Implementation: Integrating Module 2 (DAO), Module 3 (Servlet Controller), and Module 4 (JSP View) into a single flow.
24	Intro to ORM (Hibernate): Minimal Setup; Annotation based mapping (@Entity, @Table); Saving a simple object to DB without SQL.
25	Intro to Spring (IoC): Minimal Setup; Creating a Spring Bean; Demonstrating Dependency Injection using @Autowired.
26	Mini Project - Phase 1: Database Schema Design; Creating Tables; Setting up project structure and DAO Layer.
27	Mini Project - Phase 2: Building Controllers (Servlets) and Views (JSP); Implementing Authentication and CRUD flows.
28	Final Assessment: Demonstration of the working End-to-End Web Application; Project Report verification; Viva-voce.

Text Books:

T1. J. Murach and M. Urban, ***Murach's Java Servlets and JSP***, 3rd *Ed.*, Murach & Associates, 2014.
T2. H. Schildt, ***Java: The Complete Reference***, 12th *Ed.*, McGraw-Hill Education, 2021.
T3. C. Walls, ***Spring in Action***, 6th *Ed.*, Manning Publications, 2022.

Reference Books:

R1. B. Basham, K. Sierra, and B. Bates, ***Head First Servlets and JSP***, 2nd *Ed.*, O'Reilly Media, 2008.
R2. C. S. Horstmann, ***Core Java Volume II – Advanced Features***, 14th *Ed.*, Pearson Education, 2025.

Online Resources:

1. https://nptel.ac.in/courses/106105084: by Prof. I. Sengupta, IIT Kharagpur
2. https://nptel.ac.in/courses/106105191: by Prof. D. Samanta, IIT Kharagpur
3. https://docs.spring.io/spring-framework/reference/
4. https://www.tutorialspoint.com/spring_boot_jpa/index.htm

P.T.O

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

CO1	Apply Java Collections and Generics to store, manage, and retrieve application data.
CO2	Develop secure database applications using DAO and JDBC Prepared Statements.
CO3	Build server-side components with Java Servlets to handle requests, sessions, and control flow.
CO4	Design dynamic web views using JSP, EL, and JSTL while strictly following MVC architecture.
CO5	Develop an end-to-end web application integrating database, backend, and frontend layers.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Cryptography & Internet Security	L-T-P	Credits	Marks
PCR	CS4009		3-1-0	4	100

Objectives	The objective of this course is to learn key security goals and mechanisms with primary focus on cryptographic techniques used to protect computer networks and Internet from security threats.
Pre-Requisites	Knowledge of computer networks and internet technologies is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction, Computer Security Concepts, Security Attacks, Services, and Mechanisms; Symmetric Cipher model, Cryptography & Cryptanalysis; Substitution Techniques, Monoalphabetic Ciphers (Caesar, Playfair & Hill); Polyalphabetic ciphers - Vigenere, Vernam, and Transposition Ciphers.	**12 Hours**
Module-2	Integer and Modular Arithmetic, Euclidean and Extended Euclidean Algorithms, Concept of groups, rings, and fields; GF(p) vs GF(2m), Block Cipher Principles, Data Encryption Standard (DES), Advanced Encryption Standard (AES).	**12 Hours**
Module-3	Fermat's, Euler's, and Chinese Remainder Theorems, Integer Factorization, Discrete Logarithms, Discrete Logarithm Problem; Public Key Cryptography - RSA, ElGamal, Diffie-Hellman Key Exchange.	**11 Hours**
Module-4	Message Integrity and Authentication; Cryptographic Hash Functions - MD5, SHA-512, Digital Signature, and RSA digital signature algorithm.	**10 Hours**
Module-5	Key Distribution, Certificate Authority, X.509, Kerberos, E-mail security - PGP, S/MIME; Security at Transport Layer - SSL/TLS; Security at Network Layer – IPSec; Malicious Software, Firewall, Intrusion Detection.	**11 Hours**
	Total	**56 Hours**

Text Books:

T1. W. Stallings, ***Cryptography and Network Security: Principle and Practice***, 7th *Ed.*, Pearson Education, 2017.
T2. A. Kahate, ***Cryptography and Network Security***, 4th *Ed.*, McGraw-Hill Education, 2019.

Reference Books:

R1. B. A. Forouzan and D. Mukhopadhaya, ***Cryptography and Network Security***, 2nd *Ed.*, McGraw-Hill Education, 2010.
R2. C. P. Pfleeger, S. L. Pfleeger, and J. Margulies, ***Security in Computing***, 5th *Ed.*, Prentice Hall India, 2015.
R3. C. Kaufman, R. Perlman, and M. Speciner, ***Network Security: Private Communication in a Public World***, 2nd *Ed.*, Prentice Hall India, 2002.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/106105031/: by Dr. D. Mukhopadhyay, IIT Kharagpur
2. https://nptel.ac.in/courses/106105162/: by Prof. S. Mukhopadhyay, IIT Kharagpur
3. https://nptel.ac.in/courses/106106221/: by Prof. A. Choudhury, IIIT Bangalore
4. https://www.cryptool.org/en/

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

CO1	Describe the security objectives and security threats that affect our sensitive data.
CO2	Explain cryptographic techniques through modular arithmetic and discrete logarithms.
CO3	Compare and analyze the traditional & modern symmetric key cryptography algorithms.
CO4	Demonstrate public key cryptography algorithms and use of hash functions.
CO5	Apply cryptographic techniques for Internet data security through firewall & IDS.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Web Application Development	L-T-P	Credits	Marks
PCR	CS4010		3-1-0	4	100

Objectives	The objective of this course is to develop dynamic, interactive, and responsive web applications using server-side scripting, database integration, asynchronous data exchange, and modern MVC design patterns.
Pre-Requisites	Knowledge of client-side web technologies such as HTML, CSS, and JavaScript is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with programming activities and real-world examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Bootstrap & jQuery**: Introduction to the Bootstrap framework, colors, fonts, buttons, flexible grid system, responsive utilities, typography; UI components - navigation bars, content cards, interactive modals, image carousels, alerts, breadcrumbs; responsive web forms, customize Bootstrap; jQuery – Introduction to the jQuery library, selectors, DOM manipulation, and traversing, document.ready(), event handling, animations, and visual effects.	**10 Hours**
Module-2	**Scripting in PHP**: Introduction to the PHP scripting language, setup and configuration of server-side execution environments, variables and constants, data types and operators, control structures and iterative loops, built-in and user defined functions, variable scope, indexed, associative, multidimensional array, built-in array methods, text processing using string manipulation functions, regular expressions, date, and time.	**10 Hours**
Module-3	**Object Oriented PHP**: Principles of PHP Object-Oriented programming, classes and objects, constructors and destructors, inheritance and polymorphism, abstract class and interfaces, exception handling, custom exceptions; Form Handling - GET vs POST methods, form data fetching, form data validation, cookies and sessions; File Handling - read, write, append, secure file uploads, file inclusion using include and require, PDF file generation.	**12 Hours**
Module-4	**PHP with MySQL**: Integration of PHP with MySQL databases, review of fundamental relational database concepts, establishing secure database connectivity, MySQLi vs PDO extensions, CRUD operations, SQL injection attacks and prepared statements; AJAX - Introduction, architecture, XMLHttpRequest object, implementation of AJAX techniques using the jQuery, handling JSON data, dynamic and responsive content loading using AJAX with PHP and MySQL.	**12 Hours**

Cont'd. . .

Module-#	Topics	Hours
Module-5	**Design Patterns**: Principles of modern web architecture, essentials of software design patterns, Singleton and factory patterns, Model view controller architectural framework; Laravel - Introduction, installation and environment configuration, Artisan CLI, routing, controllers, views, Blade templating engine, models and database migrations, Eloquent object relational mapper, form handling and validation, session, CSRF protection, authentication & authorization.	**12 Hours**
	Total	**56 Hours**

Text Books:

T1. R. Nixon, ***Learning PHP, MySQL & JavaScript***, 6th *Ed.*, O'Reilly Media, 2021.
T2. M. Stauffer, ***Laravel: Up & Running: A Framework for Building Modern PHP Apps***, 3rd *Ed.*, O'Reilly Media, 2024.

Reference Books:

R1. L. L. Welling and L. Thomson, ***PHP and MySQL Web Development***, 5th *Ed.*, Addison-Wesley, 2016.
R2. J. Duckett, ***PHP & MySQL: Server-side Web Development***, 1st *Ed.*, Wiley, 2022.
R3. E. Freeman and E. Robson, ***Head First Design Patterns***, 2nd *Ed.*, O'Reilly Media, 2020.

Online Resources:

1. https://www.php.net/manual/en/: Official PHP Documentation
2. https://laravel.com/docs: Official Laravel Documentation
3. https://nptel.ac.in/courses/106105084: by Prof. I. Sengupta, IIT Kharagpur
4. https://getbootstrap.com/docs/5.3/getting-started/introduction/

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

CO1	Apply Bootstrap and jQuery frameworks to design responsive and interactive user interfaces.
CO2	Explain PHP fundamentals to write efficient server-side scripts for data processing.
CO3	Implement advanced PHP concepts like OOP, state management, and server-side file handling.
CO4	Develop secure, database-driven web applications using PHP, MySQL, and AJAX technologies.
CO5	Design scalable web applications utilizing MVC architecture and the Laravel PHP framework.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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	PSO1	PSO2	PSO3
CO1	2	2	2		3					1	3	2	2
CO2	3	2	1		2					1	3	2	2
CO3	3	3	2		2	1				2	3	3	2
CO4	3	3	2		3	2				2	3	3	3
CO5	3	3	3		3	1				3	3	3	3

Category	Code	Entrepreneurship Development	L-T-P	Credits	Marks
UCR	CS4011		3-0-0	3	100

Objectives	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.
Pre-Requisites	General knowledge of any business and its operations is adequate.
Teaching Scheme	Regular classroom lectures with use of ICT as needed. Each session is planned to be interactive with real-life examples & case studies.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Concept of Entrepreneurship, Characteristics of successful entrepreneur, Growth of entrepreneurship in India. Role of Entrepreneurship in Economic Development, The Entrepreneurial Process, Entrepreneurial Motivation. Entrepreneurial Competencies. Developing Entrepreneurial Competencies.	**8 Hours**
Module-2	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.	**8 Hours**
Module-3	Business Plan - Meaning, Contents and significance, Formulation, Presentation to the investors, Techno-economic Feasibility Assessment - A preliminary Project Report, Details Project Report, Project Appraisal, Methods of Project Appraisal.	**9 Hours**
Module-4	Creating a successful financial plan, Basic financial statements, Ratio Analysis, Break-even Analysis; Marketing Management of SMEs, Problems of HRM – Relevant Labour – laws, Forms of Business ownership, Institutional Finance to entrepreneurs, Source of financing, Institutional support to entrepreneurs.	**9 Hours**
Module-5	The importance of Intellectual Property, Patents, Trade Mark, Copyrights, Trade secrets, Intellectual property audit, Start up Policy of Centre, State, and MSME sectors, Problems of MSME, Sickness in small scale enterprises, Govt. policies on revival of sickness and remedial measures.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. B. R. Barringer and R. D. Ireland, ***Entrepreneurship***, 2nd *Ed.*, Pearson Education, 2008.
T2. Z. Thomas and S. Norman, ***Essentials of Entrepreneurship and Small Business Management***, 5th *Ed.*, PHI Learning, 2009.
T3. S. S. Khanka, ***Entrepreneurial Development***, 4th *Ed.*, S. Chand & Co., 2010.

Reference Books:

R1. P. Chavantimath, ***Entrepreneurship Development and Small Business Enterprises***, 3rd *Ed.*, Pearson Education, 2018.
R2. H. D. Robert and P. M. Shephard, ***Entrepreneurship***, 6th *Ed.*, McGraw-Hill Education, 2007.

R3. P. C. Jain, ***Hand Book for New Entrepreneurs***, 4th *Ed.*, Oxford University Press, 2004.
R4. J. A. Timmons and S. Spinelli Jr., ***New Venture Creation: Entrepreneurship for the 21st Century***, 8th *Rev. Ed.*, Tata McGraw-Hill, 2009.
R5. R. Roy, ***Entrepreneurship Management***, 1st *Ed.*, Oxford University Press, 2008.

Online Resources:

1. https://nptel.ac.in/courses/110106141: by Prof. C. B. Rao, IIT Madras
2. https://nptel.ac.in/courses/127105007: by Prof. M. K. Mondal, IIT Kharagpur
3. https://nptel.ac.in/courses/110107094: by Prof. V. Sharma & 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	Analyze 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:

PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Machine Learning	L-T-P	Credits	Marks
PEL	CS4016		3-0-0	3	100

Objectives	The objective of this course is to learn fundamental concepts and methods of machine learning along with analysis of large data sets.
Pre-Requisites	Basic knowledge of engineering mathematics, linear algebra, probability and statistics is required.
Teaching Scheme	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

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Overview of supervised learning, K-nearest neighbor, Multiple linear regression, Shrinkage methods (Ridge regression, Lasso regression), Subset selection, Linear discriminant analysis, Logistic regression.	**9 Hours**
Module-2	Bias, Variance, and model complexity, Cross-validation, Confusion matrix, Bootstrap methods, Regression and classification trees, Random forest, Boosting methods, AdaBoost.	**8 Hours**
Module-3	Generative model for discrete data (Bayesian concept learning, Naive Bayes classifier), SVM for classification, Reproducing kernels, SVM for regression.	**8 Hours**
Module-4	Clustering (K-means, spectral clustering), Feature extraction (Principal component analysis , Kernel based PCA, Independent component analysis, Non-negative matrix factorization).	**9 Hours**
Module-5	Introduction to Reinforcement learning; Single state case - K-Armed bandit, Elements of Reinforcement learning, Model-based learning (Value iteration, Policy iteration).	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. T. Hastie, R. Tibshirani, and J. Friedman, ***The Elements of Statistical Learning - Data Mining, Inference, and Prediction***, 2nd *Ed.*, Springer, 2009.
T2. S. Haykin, ***Neural Networks and Learning Machines***, 3rd *Ed.*, Pearson Education, 2009.
T3. E. Alpaydın, ***Introduction to Machine Learning***, 2nd *Ed.*, 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***, 1st *Ed.*, Springer, 2013.
R2. T. M. Mitchell, ***Machine Learning***, 1st *Ed.*, McGraw Hill Education, 2013.
R3. C. M. Bishop, ***Pattern Recognition and Machine Learning***, 1st *Ed.*, Springer, 2006.

Online Resources:

1. https://nptel.ac.in/courses/106105152: by Prof. S. Sarkar, IIT Kharagpur
2. https://nptel.ac.in/courses/106106198: Prof. B. Srinivasan and Prof. G. Krishnamurthi, IIT Madras
3. https://nptel.ac.in/courses/106106139: by Prof. B. Ravindran, IIT Madras

P.T.O

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

CO1	Apply supervised learning methods to solve real-life problems.
CO2	Analyze the problem and select the most suitable supervised model for implementation.
CO3	Implement important classification and regression models to real-life problems.
CO4	Preform clustering operation on a given data by extraction of important features.
CO5	Apply the concepts of reinforcement learning to solve relevant real-life problems.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Compiler Design	L-T-P	Credits	Marks
PEL	CS4017		3-0-0	3	100

Objectives	The objective of this course is to learn the key components of compiler and the principles involved in design of compilers for modern computer languages.
Pre-Requisites	Knowledge of formal language and automata theory and proficiency in any programming language is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on algorithms, problem solving, and examples.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction to Compilers - Language Processors, Structure of a Compiler; Lexical Analysis - Role of the Lexical Analyzer, Input Buffering, Specification of Tokens, Recognition of Tokens, Finite Automata, Regular Expressions to Automata, Optimization of DFA-Based Pattern Matchers.	**8 Hours**
Module-2	Syntax Analysis - Role of Parser, Grammars – Context-free grammars – Writing a grammar; Top-Down Parsing – Recursive Descent Parser, FIRST & FOLLOW, LL(l) Grammars, Non-Recursive Predictive Parsing; Bottom-Up Parsing - Reductions, Handle Pruning, Shift-Reduce Parsing, Simple LR-Items, LR(O) Automaton, LR-Parsing Algorithm, Constructing SLR-Parsing Tables, More Powerful LR Parsers (CLR & LALR).	**10 Hours**
Module-3	Syntax Directed Translation - Syntax directed Definitions, Evaluation Orders for SDD's, Syntax-Directed Translation Schemes; Intermediate-Code Generation - Variants of Syntax Trees, Three Address Code, Translation of Expressions, Translation of Array References, Short-Circuit Code, Backpatching.	**8 Hours**
Module-4	Run-Time Environment - Symbol Tables, Runtime Environments, Storage organization, Activation Trees & Records; Code Generation - Issues in the Design of a code generator, Basic Blocks and Flow Graphs, Optimization of Basic Blocks.	**8 Hours**
Module-5	Code Optimization - Peephole Optimization, Principal Sources of Optimization, Data Flow Analysis, Reaching Definitions, Live-Variable Analysis, Available Expressions, Loops in Flow Graphs, Dominators, Depth-First Ordering, Back Edges and Reducibility.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. A. V. Aho, M. S. Lam, R. Sethi, and J. D. Ullman, ***Compilers: Principles, Techniques and Tools***, 2nd *Ed.*, Pearson Education, 2009.

Reference Books:

R1. K. D. Cooper and L. Torczon, ***Engineering a Compiler***, 2nd *Ed.*, Morgan Kaufmann, 2011.
R2. A. I. Holub, ***Compiler Design in C***, 2nd *Ed.*, Prentice Hall of India, 2002.

P.T.O

Online Resources:

1. https://nptel.ac.in/courses/106106237: by Prof. R. Narse, IIT Madras
2. https://nptel.ac.in/courses/106105190: by Prof. S. Chattopadhyay, IIT Kharagpur
3. https://nptel.ac.in/courses/106104123: by Prof. S. K. Aggarwal, IIT Kanpur
4. https://nptel.ac.in/courses/106108113: by Prof. Y. N. Srikanth, IISc Bangalore

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

CO1	Explain the basics a compiler, language processors, lexical analyzers, and token recognition.
CO2	Analyze context-free grammars and construct parsers using different parsing techniques.
CO3	Apply syntax-directed translation and intermediate code and backpatching techniques.
CO4	Describe runtime environments, activation records, and basic code generation strategies.
CO5	Adapt optimization techniques, global data flow analysis, development in compilation design.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Cloud Computing	L-T-P	Credits	Marks
PEL	CS4018		3-0-0	3	100

Objectives	The objective of this course is to learn the fundamental concepts of cloud computing platforms, technologies, service, and deployment models including commercial implementations, and security aspects of applications on cloud.
Pre-Requisites	Knowledge on computer networking, client-server concepts, internet and web technologies is required.
Teaching Scheme	Regular classroom lectures with use of ICT as required; sessions are planned to be interactive with focus on examples, case-studies, and latest trends.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Client/Server systems, Thin & Thick Clients, Centralized Computing, Parallel & Distributed Computing, Amdahl's Law, P2P Computing, Cluster Computing, Grid Computing, Utility Computing, Autonomic Computing, Hosting, Data Center (overview), Dynamic Data Center.	**8 Hours**
Module-2	**Cloud Concepts & Technologies**: Cloud Computing, NIST definition, Characteristics, Service and Deployment Models, Cloud Service Examples, Cloud-based Services and Applications. Load Balancing; Virtualization - Hypervisor Types, Scalability & Elasticity, Replication, Monitoring, Software Defined Networking (SDN), Network Function Virtualization, Service Level Agreements (SLA), Billing.	**9 Hours**
Module-3	**Cloud Services & Platforms**: Amazon Web Services - Elastic Compute Cloud (EC2), Simple Storage Services (S3), Simple Queuing Service (SQS), Database Services, Application Services, Content Delivery Services, Analytics Services, Deployment and Management Services, Cloud Microservices (Overview - Docker & Kubernetes).	**9 Hours**
Module-4	**Cloud Application Design**: Considerations for Scalability, Reliability, Availability, Security, Maintenance and Upgradation, Performance; Reference Architecture for Cloud Applications, Cloud Application Design Methodologies (SOA), Data Storage Approaches; Cloud Application Benchmarking & Tuning, Workload Characteristics, Application Performance Metrics, Benchmarking Tools, Deployment Prototyping, Load Testing and Bottleneck Detection.	**8 Hours**
Module-5	**Cloud Security**: Introduction, Security Issues in the Cloud, Components of Security, Attacks and Classes of Threats, CSA Security Architecture, Authentication, Authorization, Identity and Access Management, Infrastructure Security, Data Security, Privacy, Auditing and Compliance, Data Life Cycle.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. A. Bahga and V. Madisetti, ***Cloud Computing : A Hands-On Approach***, 1st *Ed.*, Orient Blackswan, 2014.

T2. K. Hwang, G. C. Fox, and J. J. Dongarra, ***Distributed and Cloud Computing - From Parallel Processing to the Internet of Things***, 1st *Ed.*, Elsevier, 2012.
T3. T. Mather, S. K. Swamy, and S. Latif, ***Cloud Security and Privacy : An Enterprise Perspective on Risks and Compliance***, 1st *Ed.*, O'Reilly Media, 2009.

Reference Books:

R1. A. T. Velte, T. J. Velte, and R. Elsenpeter, ***Cloud Computing : A Practical Approach***, 1st *Ed.*, McGraw Hill Education, 2017.
R2. B. Sosinsky, ***Cloud Computing Bible***, 1st *Ed.*, Wiley-India, 2011.
R3. T. Erl, Z. Mahmood, and R. Puttini, ***Cloud Computing : Concepts, Technology & Architecture***, 1st *Ed.*, Pearson India Education, 2014.

Online Resources:

1. https://nptel.ac.in/courses/106/105/106105167/: by Prof. S. K. Ghosh, IIT Kharagpur
2. https://nptel.ac.in/courses/106/104/106104182/: by Prof. R. Misra, IIT Kanpur
3. https://www.coursera.org/learn/cloud-computing: Prof. I. Gupta, University of Illinois UC
4. http://web.mit.edu/6.897/www/readings.html: by Prof. H. Balakrishnan, MIT

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

CO1	Describe computing paradigms and explain standard cloud computing models.
CO2	Explain key concepts along with the enabling technologies of cloud computing.
CO3	Explore various types of cloud computing services and user-access management.
CO4	Apply design principles and methodologies for developing applications on the cloud.
CO5	Assess the importance of security and privacy of applications and data in cloud environment.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Software Testing	L-T-P	Credits	Marks
PEL	CS4019		3-0-0	3	100

Objectives	The objective of this course is to learn the principles, techniques, and practices of software testing applying systematic testing methodologies to ensure software quality, reliability, and security, and develop analytical and professional skills required for testing in real-world software development environments.
Pre-Requisites	Basic knowledge of programming, software development life cycle (SDLC), and data structures is required.
Teaching Scheme	Regular classroom lectures supported with ICT tools; emphasis on interactive discussions, real-world software defect case studies, test design exercises, and exposure to contemporary testing tools and practices.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Fundamentals of Software Testing**: Introduction to Software Quality and Testing, Objectives of Software Testing, Verification and Validation, Software Errors, Faults, and Failures, Principles of Testing, SDLC vs. STLC, Software Testing Life Cycle, Role of Testing in Agile and DevOps; Levels of Testing – Unit, Integration, System, and Acceptance Testing.	**8 Hours**
Module-2	**Static & Dynamic Testing Techniques**: Static Testing – Reviews, Walkthroughs, and Inspections; Dynamic Testing Approaches; Black Box Testing Techniques – Equivalence Class Partitioning, Boundary Value Analysis, Decision Table Testing, State Transition Testing; White Box Testing Techniques – Statement, Branch, Path, and Condition Coverage.	**8 Hours**
Module-3	**Test Design, Management, and Metrics**: Test Planning and Test Strategy, Test Case Design and Documentation, Test Scenarios and Test Data Generation, Defect Life Cycle and Defect Tracking, Test Estimation Techniques, Test Metrics and Measurements, Risk-based Testing, Test Reporting and Closure Activities.	**9 Hours**
Module-4	**Advanced & Specialized Testing**: Regression Testing and Retesting, Smoke and Sanity Testing, Performance Testing – Load, Stress, and Scalability Testing; Security Testing Fundamentals, Usability and Accessibility Testing, Compatibility and Reliability Testing.	**8 Hours**
Module-5	**Tools, Ethics, and Trends**: Introduction to Automated Testing and Tools, Test Automation Frameworks, Introduction to CI/CD and DevOps Testing, AI and ML in Software Testing, Ethical Issues in Software Testing - Professional Responsibility and Compliance, Cyber Laws and Quality Standards; Sustainable and Reliable Software Systems; Future Trends in Software Testing.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. R. S. Pressman and B. R. Maxim, ***Software Engineering: A Practitioner's Approach***, 9th *Ed.*, McGraw-Hill Education, 2020.

T2. G. J. Myers, C. Sandler, and T. Badgett, ***The Art of Software Testing***, 3rd *Ed.*, Wiley, 2011.

Reference Books:

R1. C. Kaner, J. Falk, and H. Q. Nguyen, ***Testing Computer Software***, 2nd *Ed.*, Dreamtech Press, 2000.
R2. S. Desikan and G. Ramesh, ***Software Testing: Principles and Practice***, 1st *Ed.*, Pearson Education, 2012.

Online Resources:

1. https://nptel.ac.in/courses/106105150: by Prof. R. Mall, IIT Kharagpur
2. https://nptel.ac.in/courses/106101163: by Prof. M. D'Souza, IIIT Bangalore.
3. https://nptel.ac.in/courses/106105182: by Prof. R. Mall, IIT Kharagpur
4. https://www.guru99.com/software-testing.html
5. https://www.softwaretestinghelp.com

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

CO1	Explain fundamental concepts, principles, and processes of software testing.
CO2	Apply appropriate black-box and white-box testing techniques to identify defects.
CO3	Design effective test plans, test cases, and defect management strategies.
CO4	Evaluate software quality using advanced testing techniques and tools.
CO5	Analyze ethical, professional, and societal implications of software testing practices.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Software Project Management	L-T-P	Credits	Marks
PEL	CS4020		3-0-0	3	100

Objectives	The objective of this course is to learn software project management principles, apply estimation and scheduling models, perform earned value analysis, analyze make-or-buy decision, manage risks, maintain quality, demonstrate leadership, understand ethics, sustainability in professional software environments.
Pre-Requisites	Knowledge of Software Engineering and Software Development Life Cycle (SDLC) is required
Teaching Scheme	Regular classroom lectures supported by ICT tools, numerical problem-solving sessions, case studies, project planning exercises, exposure to project management tools, presentations, and group discussions.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Software Project vs General Project, Project Life Cycle Models, Roles & Responsibilities of a Project Manager, Stakeholder Analysis, Project Charter, Feasibility Study - Technical, Economic, Operational; Make-or-Buy Decision Analysis - Cost-benefit analysis, Strategic alignment, Outsourcing risks; Overview of Agile and Traditional SDLC Models.	**8 Hours**
Module-2	**Planning, Estimation & Scheduling**: Scope Management, Work Breakdown Structure (WBS); Effort Estimation – LOC, Function Points, COCOMO; Cost Estimation; Scheduling – Gantt Charts, PERT, CPM; Critical Path Analysis; Resource Allocation and Leveling, Milestones and Deliverables.	**8 Hours**
Module-3	**Risk, Quality & Earned Value Management**: Risk Identification and Analysis, Risk Mitigation Strategies, Risk Monitoring; Software Quality Planning - Quality Assurance vs Quality Control; Metrics and KPIs; Earned Value Management (EVM) - Planned Value (PV), Earned Value (EV), Actual Cost (AC), Cost Variance (CV), Schedule Variance (SV), Cost Performance Index (CPI), Schedule Performance Index (SPI), Estimate at Completion (EAC), Forecasting, and Interpretation.	**9 Hours**
Module-4	**Monitoring, Agile & DevOps**: Project Tracking and Control, Change Management, Configuration Management, Issue Management; Agile Project Management – Scrum, Sprint Planning, Product Backlog, Burn-down Charts; DevOps Integration; Project Closure and Post-Implementation Review.	**8 Hours**
Module-5	**Leadership, Ethics & Sustainability**: Team Building, Leadership, Conflict Resolution, Communication and Reporting; Legal and Ethical Issues - Intellectual Property Rights, Cyber Laws, Global and Cultural Considerations; Sustainable and Green Project Management; Lifelong Learning and Emerging Trends.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. B. Hughes and M. Cotterell, ***Software Project Management***, 5th *Ed.*, Tata McGraw-Hill, 2011.

T2. P. Jalote, ***Software Project Management in Practice***, 1st *Ed.*, Pearson, 2003.

Reference Books:

R1. W. Royce, ***Software Project Management: A Unified Framework***, Addison-Wesley Professional, 2010.
R2. K. Schwalbe, ***Information Technology Project Management***, 8th *Ed.*, Cengage Learning, 2010.

Online Resources:

1. https://nptel.ac.in/courses/106101061: by Prof. R. K. Joshi, Bellur, and Sarda, IIT Bombay
2. https://nptel.ac.in/courses/106105182: by Prof. R. Mall, IIT Kharagpur
3. https://www.pmi.org/learning/library
4. https://www.atlassian.com/agile

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

CO1	Explain PM frameworks, feasibility, and make-or-buy decisions in software projects.
CO2	Apply estimation and scheduling models to design effective software project plans.
CO3	Assess risks, quality metrics, and earned value to monitor project performance.
CO4	Apply agile, DevOps, and modern tools for effective software project control.
CO5	Demonstrate leadership, ethics, communication, and sustainability in projects.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	E-Commerce & Knowledge Management	L-T-P	Credits	Marks
PEL	CS4021		3-0-0	3	100

Objectives	The objective of this course is to learn the key concepts of e-commerce including technological infrastructure, revenue models, processes of web presence building, knowledge management components and its use.
Pre-Requisites	Basic knowledge of Web technologies, Client-Server applications and Database Management systems is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with problem solving activities.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	Introduction, Terminologies, Impacts of E-Commerce, E-Commerce vs E-Business, Business Models, Key Business Processes, Advantages and Disadvantages of E-Commerce; E-Commerce Technological Infrastructure; The Environment of E-Commerce – Legal, Ethical, and Tax Issues.	**9 Hours**
Module-2	Key Revenue Models of E-Commerce, Building Effective Web Presence, Improving Web Site Usability, Connecting with Customers; Marketing on the Web - Key Strategies, Communicating with Market Segments, Beyond Market Segmentation; Change in Intensity of Customer Relationship, Advertising on the Web, E-Mail Marketing, Technology-enabled CRM, Creating and Maintaining Brands on the Web, Search Engine Positioning.	**10 Hours**
Module-3	Business-to-Business (B2B) Activities – Purchasing, Logistics, Support Activities, Electronic Data Interchange, Supply Chain Management, E-Marketplaces and Portals, Social Networking, Mobile Commerce, Types of Online Auctions.	**9 Hours**
Module-4	E-Commerce Software – Web Hosting, Basic and Advanced Functions of E-Commerce Software, E-Commerce Software for Small, Midsize, and Large Businesses.	**6 Hours**
Module-5	Knowledge Management Systems (KMS), Components of KMS, Role of Knowledge Management in E-Commerce, Benefits of Integrating Knowledge Management with E-Commerce, Challenges in Knowledge Management in E-Commerce.	**8 Hours**
	Total	**42 Hours**

Text Books:

T1. P. T. Joseph, ***E-Commerce: An Indian Perspective***, 7th *Ed.*, PHI Learning, 2023.
T2. G. P. Schneider, ***Electronic Commerce***, 12th *Ed.*, Cengage Learning, 2016.
T3. K. K. Gupta, ***Knowledge Management***, 2nd *Ed.*, Oxford University Press, 2019.

Reference Books:

R1. K. C. Laudon and C. G. Traver, ***E-Commerce: Business, Technology, Society***, 17th *Ed.*, Pearson Education, 2023.
R2. C. V. S Murthy, ***E-commerce: Concepts, Models & Strategies***, 1st *Ed.*, Himalaya Publishing, 2018.

R3. W. R. King (Ed.), ***Knowledge Management and Organizational Learning***, 2nd *Ed.*, Springer, 2009.

Online Resources:

1. https://nptel.ac.in/courses/110105083: by Prof. M. Jenamani, IIT Kharagpur
2. https://nptel.ac.in/courses/110106045: by Prof. G. Srinivasan, IIT Madras
3. https://nptel.ac.in/courses/110105076: by Prof. K. B. L. Srivastava, IIT Kharagpur
4. https://warwick.ac.uk/fac/soc/wbs/conf/olkc/archive/oklc3/papers/id240.pdf: by R. McLean and N. M. Blackie, University of Salford, UK.
5. https://www.researchgate.net/publication/240790062_Knowledge_Management_in_an_E-commerce_System: by Oklahoma State University, USA

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

CO1	Understand core e-commerce concepts, models, processes, infrastructure, and legal issues.
CO2	Explain e-commerce revenue models, web marketing strategies, CRM, branding, and SEO.
CO3	Explore B2B e-commerce, SCM, EDI, e-marketplaces, m-commerce, and online auctions.
CO4	Analyze e-commerce software hosting, functions, and use across business sizes.
CO5	Apply KMS components and their role, benefits, and challenges in e-commerce integration.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO9	Ability to understand the impact of system solutions in a contemporary, global, economical, environmental, and societal context for sustainable development.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Computer Graphics	L-T-P	Credits	Marks
PEL	CS4022		3-0-0	3	100

Objectives	The objective of this course is to learn the key concepts of computer graphics including rasterization, transformations, 3D rendering, curves, surfaces, and illumination models.
Pre-Requisites	Fundamentals of programming, linear algebra, and basic coordinate geometry is required.
Teaching Scheme	Regular classroom lectures with use of ICT as and when required; sessions are planned to be interactive with focus on examples, case-studies, and latest trends.

Evaluation Scheme

Attendance	Teacher's Assessment	Mid-Term	End-Term	Total
10	20	20	50	100

Detailed Syllabus

Module-#	Topics	Hours
Module-1	**Introduction**: Overview, Terminologies, Graphic displays, Random and raster scan displays, Frame buffer and video controller, Points and lines; Line drawing algorithms - DDA and Bresenham; Circle drawing algorithm - mid-point.	**8 Hours**
Module-2	**2D Graphics**: Basic transformation, Matrix representations and homogenous coordinates, Composite transformations, Reflections and shearing; Windowing and clipping - Viewing pipeline and transformations, 2D line clipping algorithms (Cohen Sutherland).	**8 Hours**
Module-3	**3D Graphics**: 3D object representation, 3D and Composite transformations, transformation hierarchies, Model/View/Projection matrices, Camera systems and projections, Backface detection and culling algorithm, depth Z-buffer method.	**9 Hours**
Module-4	**Curves & Surfaces**: Polygon surfaces, Parametric curves and surfaces, Quadric surfaces, Spheres, Ellipsoid; Linear and bilinear interpolation, introduction to splines, cubic splines, Bspline & Bezier curves and surfaces.	**8 Hours**
Module-5	**Illumination Models**: Lights sources - Point, Directional, Area, Ambient; Illumination methods - Ambient, Diffusion, Reflection, Specular; Shading models - Diffused and Blinn-Phong shading; RGB and CMY color models, Lookup tables.	**9 Hours**
	Total	**42 Hours**

Text Books:

T1. D. Hearn and M. P. Baker, ***Computer Graphics with OpenGL***, 4th *Ed.*, Pearson Education, 2011.
T2. F. S. Hill Jr., ***Computer Graphics Using OpenGL***, 3rd *Ed.*, Pearson Education, 2007.
T3. P. Shirley and S. Marschner, ***Fundamentals of Computer Graphics***, 5th *Ed.*, Taylor & Francis, 2022.

Reference Books:

R1. J. D. Foley, A. V. Dam, S.K. Feiner, and J. F. Hughes, ***Computer Graphics: Principles and Practice***, 3rd *Ed.*, Addison-Wesley Professional, 2013.
R2. E. Angel and D. Shreiner, ***Interactive Computer Graphics: A Top-Down Approach with OpenGL***, 7th *Ed.*, Pearson Education, 2014.

R3. S. Harrington, ***Computer Graphics: A Programming Approach***, 2nd *Ed.*, McGraw-Hill Education, 2004.
R4. D. F. Rogers and J. A. Adams, ***Mathematical Elements for Computer Graphics***, 2nd *Ed.*, McGraw-Hill Education, 1989.

Online Resources:

1. https://nptel.ac.in/courses/106106090: by Prof. S. Das, IIT Madras
2. https://nptel.ac.in/courses/106103224: by Prof. S. Bhattacharya, IIT Guwahati
3. https://nptel.ac.in/courses/106102065: by Prof. P. K. Kalra, IIT Delhi
4. https://gabrielgambetta.com/computer-graphics-from-scratch/

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

CO1	Explain rasterization algorithms and math foundations for rendering graphics primitives.
CO2	Apply 2D transformation matrices and evaluate clipping algorithms in viewing systems.
CO3	Analyze 3D transformations, projection methods, and visibility algorithms in scenes.
CO4	Evaluate parametric curves and surfaces using interpolation and spline models.
CO5	Illustrate illumination and shading models for realistic lighting in CG images and rendering.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO4	Analyze and review literature to invoke the research skills to design, interpret and make inferences from the resulting data.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO7	Function effectively both as a team leader and team member on multi disciplinary projects to demonstrate computing and management skills.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Web Application Development Lab	L-T-P	Credits	Marks
PCR	CS4012		0-0-4	2	100

Objectives	The objective of this laboratory course is to provide hands-on training in developing dynamic web applications using frontend frameworks, server-side scripting with PHP, RDBM MySQL, asynchronous data exchange, and Laravel MVC framework.
Pre-Requisites	Knowledge of HTML, CSS, and basic JavaScript including DOM manipulation and client-side design principles is required.
Teaching Scheme	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 / Project	Viva-voce	Total
10	30	15	30	15	100

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Bootstrap Layouts: Implementation of the grid system, responsive utilities, and basic typography to structure a web page.
2	Bootstrap Components: Design user interfaces using pre-built components like navbars, cards, modals, and responsive forms.
3	jQuery DOM & Events: Element selection, DOM manipulation, handling click and hover events, applying basic visual animations.
4	PHP Environment & Syntax: Setup of local server environment, execution of fundamental scripts utilizing variables, data types, and operators.
5	PHP Control Structures: Implementation of conditional statements and iterative loops for dynamic data generation.
6	PHP Functions: Creation of user-defined functions, handling arguments, returning values, and managing variable scope.
7	PHP Arrays: Operations on indexed, associative, and multidimensional arrays including sorting and traversal.
8	String & Date Processing: Utilization of built-in string manipulation functions, date formatting, and regular expressions for basic pattern validation.
9	Object-Oriented PHP Basics: Definition of classes, instantiation of objects, implementing constructors, and encapsulating data.
10	Advanced OOP: Implementation of class inheritance, method overriding, and utilization of interfaces.
11	Form Handling & Validation: Processing user inputs using GET and POST methods, server-side data sanitization, and handling missing fields.
12	State Management: Implementation of secure login mechanisms utilizing cookies for tracking and sessions for authentication.
13	File Handling: Writing text logs, reading file contents, and implementing secure image upload functionalities.
14	PDF Generation: Integration of third-party libraries like FPDF or TCPDF to generate formatted downloadable reports from form data.

Cont'd. . .

Experiment-#	Assignment/Experiment
15	Database Setup & Connectivity: Creation of relational database tables via phpMyAdmin and establishing secure connections using PHP Data Objects.
16	CRUD Operations: Create & Read - Dynamic insertion of user data into MySQL tables and fetching records to display in HTML tables.
17	CRUD Operations: Update & Delete: Implementation of functional buttons to edit existing database records and securely delete entries.
18	Security Implementations: Refactoring standard SQL queries to utilize prepared statements for robust SQL injection prevention.
19	AJAX Fundamentals: Initiating asynchronous requests utilizing XMLHttpRequest and fetching raw text data from the server.
20	AJAX with jQuery & JSON: Fetching and parsing JavaScript Object Notation data dynamically utilizing jQuery AJAX methods.
21	PHP, MySQL & AJAX Integration: Building a dynamic search bar that fetches real-time database results without reloading the web page.
22	MVC Architecture Design: Structuring a basic application separating logic, database queries, and presentation templates manually.
23	Laravel Framework Setup: Installation of the framework, environment configuration, and defining fundamental web routes.
24	Laravel Controllers & Views: Creating controllers to handle business logic and passing dynamic variables to Blade templating views.
25	Laravel Database Migrations: Writing migration scripts to create structured database schemas directly from the command line.
26-27	Capstone Project: Requirement analysis, UI setup, implementation of core features, database integration, and MVC logic application.
28	Final Assessment: Comprehensive code review, practical project demonstration, and viva voce evaluation.

Text Books:

T1. R. Nixon, ***Learning PHP, MySQL & JavaScript***, 6th *Ed.*, O'Reilly Media, 2021.
T2. M. Stauffer, ***Laravel: Up & Running: A Framework for Building Modern PHP Apps***, 3rd *Ed.*, O'Reilly Media, 2024.

Reference Books:

R1. L. L. Welling and L. Thomson, ***PHP and MySQL Web Development***, 5th *Ed.*, Addison-Wesley, 2016.
R2. J. Duckett, ***PHP & MySQL: Server-side Web Development***, 1st *Ed.*, Wiley, 2022.

Online Resources:

1. https://www.php.net/manual/en/: Official PHP Documentation
2. https://getbootstrap.com/docs/5.3/getting-started/introduction/
3. https://api.jquery.com/: jQuery API Documentation
4. https://laravel.com/docs: Official Laravel Documentation

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

CO1	Design responsive user interface components utilizing Bootstrap and jQuery frameworks.
CO2	Implement foundational PHP scripts employing arrays, functions, and regular expressions.
CO3	Develop interactive forms, state management, object-oriented logic, and file handling.

Cont'd. . .

CO4	Build secure database-driven web applications integrating MySQL and AJAX.
CO5	Implement scalable web applications employing MVC architecture principles and the Laravel.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO6	Solve and work with a professional context pertaining to ethics, social, cultural and cyber regulations.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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

Category	Code	Emerging Technologies Lab	L-T-P	Credits	Marks
SEC	IP4014		0-0-4	2	100

Objectives	The purpose of this course is to learn modern frontend development using ECMAScript (ES6+) and React.js, and to gain hands-on experience in building responsive, data-driven Single Page Applications (SPAs) with RESTful APIs, state management, and client-side routing.
Pre-Requisites	Knowledge of HTML5, CSS3, and basic JavaScript, including variables, control structures, and fundamental DOM manipulation is required.
Teaching Scheme	Regular laboratory classes conducted under the supervision of the teacher. The experiments shall comprise of programming assignments involving Client-side programming, connectivity with Server, and Project development.

Evaluation Scheme

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

Detailed Syllabus

Experiment-#	Assignment/Experiment
1	Dynamic element creation: createElement, appendChild, remove; Event-driven UI updates, Callback Function
2	ES6 Basics: let vs const, Arrow functions, Template literals, Destructuring
3	ES6 Advanced Features: Spread & Rest operators, Default parameters, Enhanced object literals
4	Higher-order Array Methods: forEach, map, reduce, filter, sort, find, some, every
5	Asynchronous JavaScript: Callbacks vs Promises, then, catch, async/await
6	API Integration: REST concepts, JSON format, HTTP request methods and status codes, AXIOS, Fetch data from a public API
7	Browser Storage: localStorage & sessionStorage, Storing and retrieving JSON data
8	CSS Frameworks: Utility classes, Utilization of pre-built framework components
9	Layouts: Flexbox helpers, Grid helpers, Responsive prefixes
10	Responsive UI: Cards, Navbars, Mobile Menus, Hover states
11	Capstone UI: Design and development of a professional Landing Page
12	React Ecosystem: Environment Setup, JSX Syntax, Rendering initial components
13	Components & Props: Functional Components, passing data via props, Destructuring props, Children prop
14	Event Handling: onClick, onChange, passing functions as props
15	State Management: The useState hook, Immutability principle
16	Rendering Lists: Using .map() to render components, the importance of the key prop
17	Forms & Controlled Components: Handling multiple inputs, Two-way data binding, form submission
18	The useEffect Hook: Dependency arrays ([] vs [prop]), Component Did Mount / Update / Unmount concepts
19	API Integration in React: fetch inside useEffect, Loading states, Error handling states

Cont'd. . .

Experiment-#	Assignment/Experiment
20	React Router DOM: <BrowserRouter>, <Routes>, <Route>, <Link> vs <a> tag
21	Dynamic Routing: URL Parameters (:id), useParams hook, 404 pages
22	Context API and Global State: Prop Drilling problem, createContext, useContext
23	TypeScript Fundamentals: Introduction to Static Typing, Defining specific types and interfaces for variables and functions
24	Advanced Data Modeling: Complex Types - Implementation of Array, Tuple, Object, and Enum types to enforce strict data structures in applications
25 - 27	Capstone Project: Requirement Analysis & Setup, Core Feature Implementation, Logic & State Integration
28	Final Assessment: Code review, project demonstration, and viva voce

Text Books:

T1. M. Haverbeke, ***Eloquent JavaScript: A Modern Introduction to Programming***, 3rd *Ed.*, No Starch Press, 2018.
T2. R. Wieruch, ***The Road to React: Your Journey to Master Plain Yet Pragmatic React.js***, 2025 Edition, Zaccheus Entertainment, 2025.
T3. A. Banks and E. Porcello, ***Learning React: Modern Patterns for Developing React Apps***, 2nd *Ed.*, O'Reilly Media, 2020.

Reference Books:

R1. D. Flanagan, ***JavaScript: The Definitive Guide***, 6th *Ed.*, O'Reilly Media, 2011.
R2. B. Cherny, ***Programming TypeScript: Making Your JavaScript Applications Scale***, O'Reilly Media, 2019.

Online Resources:

1. https://developer.mozilla.org/en-US/: MDN Web Docs
2. https://react.dev/learn/: React Official Documentation
3. https://www.typescriptlang.org/docs/: TypeScript Documentation
4. https://tailwindcss.com/docs/installation/using-vite/: Tailwind CSS Documentation

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

CO1	Apply ES6 & JavaScript to refactor, optimize, and improve maintainability of legacy code.
CO2	Design responsive & visually appealing UI using CSS frameworks, Flexbox, and Grid.
CO3	Develop interactive & reusable UI components using React components, props, and hooks.
CO4	Integrate RESTful APIs into client-side apps using asynchronous JavaScript functions.
CO5	Build a robust, type-safe React SPA using React Router, Context API, and TypeScript.

Program Outcomes Relevant to the Course:

PO1	Apply knowledge of computing fundamentals, mathematics and domain knowledge appropriate for computing models from defined problems and requirements.
PO2	Design and develop applications to analyze and solve all computer science related problems.
PO3	Design applications for any desired needs with appropriate considerations for any specific need on societal and environmental aspects.
PO5	Integrate and apply efficiently the contemporary IT tools to all computer applications.
PO8	Communicate effectively and present technical information in oral and written reports.
PO10	Appreciate the importance of goal setting and to recognize the need for life-long learning.

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

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CO3	3	3	2		3			2		3	3	3	3
CO4	3	3	2		3			2		3	3	3	3
CO5	3	3	2		3			2		3	3	3	3



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