Appendix - II (E)

COCHIN UNIVERSITY OF SCIENCE & TECHNOLOGY

CURRICULUM & SYLLABUS
(I to VIII Semesters)

B. TECH. PROGRAMME
in
INFORMATION TECHNOLOGY
(2023 Admission onwards)

B.TECH. DEGREE PROGRAMME IN INFORMATION TECHNOLOGY

VISION

To become a world leader in higher education and research in the field of Information Technology.

MISSION

To impart state-of-the-art knowledge in the field of Information Technology with a focus on developing the required competencies and virtues to meet the requirements of the society and to become a centre of excellence in this field.

To attract graduate, post-graduate and research students and train them in innovative areas, so that they can impress various recruiters from industry and academia and also become entrepreneurs in Information Technology.

Programme Educational Objectives (PEOs):

After a few years of B. Tech. graduation in Information Technology, the candidate is expected to achieve the following PEOs.

PEO1: PREPARATION - To prepare students to excel in postgraduate programmes or to succeed in industry / technical profession through global, rigorous education.

PEO2: CORE COMPETENCE - To provide students with a solid foundation in mathematical, scientific, and engineering fundamentals required to solve engineering problems and also to pursue higher studies.

PEO3: BREADTH - To train students with good scientific and engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for real-life problems.

PEO4: PROFESSIONALISM - To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and broader social context.

PEO5: LEARNING ENVIRONMENT - To provide students with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

Programme Outcomes (POs):

A graduate of this major should be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the

limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs)

Information Technology graduates will be able to:

PSO1: Apply Computational Thinking Skills to analyze the real-world problems in different domains and develop appropriate IT solutions.

PSO2: Monitor and control various IT resources (hardware, software, and data) effectively and efficiently.

PSO3: Safeguard data from cyber-attacks using data security concepts.

PSO4: Manage the financial and organizational aspects of the IT industry.

Program Articulation Matrix

Mission Statement	**PEO1**	**PEO2**	**PEO3**	**PEO4**	**PEO5**
To impart state-of-the-art knowledge in the field of Information Technology with a focus on developing the required competencies and virtues to meet the requirements of the society and to become a centre of excellence in this field.	**3**	**3**	**3**	**3**	**3**
To attract graduate, post-graduate and research students and train them in innovative areas, so that they can impress various recruiters from industry and academia and also become entrepreneurs in Information Technology.	**3**	**3**	**3**	**3**	**3**

1-Slightly; 2- Moderately; 3- Substantially

Categories of Courses with the Breakup of Credits

Sl. No	Category of Courses	Credit breakup for Information Technology
1	Humanities and Social Sciences including Management Courses	7
2	Basic Science courses	20
3	Engineering Science Courses including workshop, drawing, basics of electronics/electrical/mechanical/computer etc.,	30
4	Professional Courses	74
5	Professional elective courses relevant to chosen specialization/discipline	18
6	Open subjects-Electives from other technical and /or emerging subjects	6
7	Project work, seminar and internship in industry or elsewhere	15
8	Mandatory courses	(noncredit)
	Total	170

Stream B: Computer Science and Engineering, Electrical and Electronics Engineering, Electronics and Communication Engineering & Information Technology.

SEMESTER I (STREAM B)

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0101B	Calculus	3	1	0	4	50	50	100
23-200-0102B	Engineering Physics	3	0	1	3	50	0	100
23-200-0103B	Introduction to Electronics devices & Circuits	3	1	0	4	50	50	100
23-200-0104B	Introduction to Electrical Engineering	3	0	0	3	50	50	100
23-200-0105B	Computer programming	3	1	0	3	50	50	100
23-200-0106B	Soft Skills Development	2	0	0	2	50	-	50
23-200-0107B	Computer Programming Laboratory	0	0	3	1	25	25	50
23-200-0108B	Basic Electrical lab	0	0	3	1	25	25	50
23-200-0109B	Language Laboratory	0	0	2	1	25	25	50
23-200-0110B	NSS/Nature conservation Activities/Yoga	0	0	1	0	-	-	-
	TOTAL	**17**	**3**	**10**	**22**			

CA – Continuous Assessment SEE – Semester End Examination

SEMESTER II (STREAM B)

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0201B	Linear Algebra & Transform Techniques	3	1	0	4	50	50	100
23-200-0202B	Engineering Chemistry	3	0	1	3	50	50	100
23-200-0203B	Digital Electronics	3	1	0	3	50	50	100
23-200-0204B	Object Oriented Programming in C++	3	1	1	4	50	50	100
23-200-0205B	Introduction to Cyber Physical Systems	3	1	0	3	50	50	100
23-200-0206B	Environmental and Life Sciences	3	0	0	3	50	50	100
23-200-0207B	Digital Electronics Lab	0	0	3	1	25	25	50
23-200-0208B	Basic Electronics Lab	0	0	3	1	25	25	50
	TOTAL	**18**	**4**	**8**	**22**			

SEMESTER III

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0301B*	Differential Equations and Complex Variables	3	1	0	3	50	50	100
23-204 -0302	Internet Programming	3	1	0	3	50	50	100
23-204 -0303**	Discrete Computational Structures	3	1	0	3	50	50	100
23-204 -0304	Database Management Systems	3	1	0	3	50	50	100
23-204-0305	Data Structures and Algorithms in C++	3	1	0	3	50	50	100
23-204 -0306	Computer Organization & Architecture	3	1	0	3	50	50	100
23-204 -0307	Hardware Design & CPS Laboratory	0	0	3	1	25	25	50
23-204 -0308	Data Structures in C++ Laboratory	0	0	3	1	25	25	50
23-204 -0309	Internship-I	0	0	0	1	50		50
	TOTAL	**18**	**6**	**6**	**21**			
Minor in Information Technology								
23-204-0310	Foundations of Data Management and Structures.	3	1	0	3	50	50	100
23-204-0311#	MOOC(Minor) Broad Area: Web Designing Technologies	0	0	0	3	0	0	100

*Common for CS/EEE/ECE/IT

**Common for CS/IT

Internship-1 of a minimum duration of two weeks (10 working days) after second semester and the evaluation will take place during the III semester. For Lateral Entry students a mini project carried out can be considered equivalent to Internship-I

#Students should take Massive Open Online Courses (MOOCs) approved by the concerned Division/Board of Studies

SEMESTER IV

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-200-0401B*	Numerical and Statistical Techniques	3	1	0	3	50	50	100
23-204 -0402	Data Communication	3	1	0	3	50	50	100
23-204 -0403	Operating Systems	3	0	0	3	50	50	100
23-204 -0404	Software Engineering	3	0	0	3	50	50	100
23-204 -0405	Formal Languages and Automata Theory	3	1	0	3	50	50	100
23-204 -0406	Design and Analysis of Algorithms	3	0	0	3	50	50	100
23-200 -0407**	Universal Human Values	2	1	0	3	25	25	50
23-204 -0408	Operating Systems Lab	0	0	3	1	25	25	50
23-204 -0409	Mini Project– DBMS based	0	0	3	1	25	25	50
	TOTAL	**20**	**4**	**6**	**23**			
Minor in Information Technology								
23-204-0410#	MOOC Broad Area: Introduction to Data Communications and Networking	0	0	0	3	0	0	100
Honours in Information Technology								
23-204-0411	Computational Thinking	3	1	0	3	50	50	100

*Common for CS/EE/EC/IT

**Common for All branches

#Students should take Massive Open Online Courses(MOOCs) approved by the concerned Division/Board of Studies(BoS)

SEMESTER V

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-204 -0501	Compiler Design	3	1	0	3	50	50	100
23-204 -0502	Software Design and Architecture	3	1	0	3	50	50	100
23-204 -0503	Internet of Things	3	1	0	3	50	50	100
23-204 -0504	Big Data Analytics	3	1	0	3	50	50	100
23-204 -0505	Internet Architecture & Design	3	1	0	3	50	50	100
23-204 -05**	Professional Elective – I(MOOC)	0	0	0	3	-	-	100
23-204 -0510	Networking & Edge Computing Lab	0	0	3	1	25	25	50
23-204 -0511	Software Engineering Lab	0	0	3	1	25	25	50
23-204 -0512	Internship-II	0	0	0	1	50		50
	TOTAL	**15**	**5**	**6**	**21**			
Minor in Information Technology								
23-204-0513	Big Data Analytics and Machine Learning	3	1	0	3	50	50	100
Honours in Information Technology								
23-204-0514	Research Methodology and Intellectual Property Rights	3	1	0	3	50	50	100
23-204-0515#	MOOC 1 Broad Area: Data Engineering and Analytics	0	0	0	3	0	0	100

Internship-II of a minimum duration of two weeks (10 working days) after fourth semester and the evaluation will take place during the V semester.

#Students should take Massive Open Online Courses(MOOCs) approved by the concerned Division/Board of Studies(BoS)

23-204-0506 to 23-204-0509 PROFESSIONAL ELECTIVE – I (MOOC)	
Code No.	**Broad Area**
23-204 -0506(IE)	Augmented Reality
23-204 -0507	Digital marketing
23-204 -0508	Digital Canvas
23-204 -0509	Artificial Intelligence & Machine Learning

SEMESTER VI

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-204 -0601	Agile Project Methodology	3	1	0	3	50	50	100
23-204 -0602	Data Security and Cryptography	3	1	0	3	50	50	100
23-204 -0603	Deep Learning	3	1	0	3	50	50	100
23-204 -0604	Cloud Computing	3	1	0	3	50	50	100
23-204 -0605	Design and Development Mobile Application	3	1	0	3	50	50	100
23-204 -06**	Professional Elective – II	3	1	0	3	50	50	100
23-204 -0610	Cloud and Data Analytics Laboratory	0	0	3	1	25	25	50
23-204 -0611	Mini Project – Mobile App Development	0	0	3	1	25	25	50
	TOTAL	**18**	**6**	**6**	**20**			
Minor in Information Technology								
23-204-0612	MOOC Broad Area: Cloud Computing	0	0	0	3	0	0	100
Honours in Information Technology								
23-204-613	Optimization Techniques	3	1	0	3	50	50	100
23-204-614#	MOOC Broad Area: Business AI	0	0	0	3	0	0	100

#Students should take Massive Open Online Courses(MOOCs) approved by the concerned Division/Board of Studies(BoS)

23-204-0606 to 23-204-0609 PROFESSIONAL ELECTIVE – II	
Code No.	**Subject**
23-204 -0606(IE)	DevOps Engineering
23-204 -0607	Mobile Computing Technology
23-204 -0608	Recommender System
23-204 -0609	Mining of Massive Datasets

SEMESTER VII

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-204 -0701	Financial Management & E-banking	3	1	0	3	50	50	100
23-204 -0702	Design Thinking and Innovations	3	1	0	3	50	50	100
23-204 -0703	Computer Graphics and Visual Computing	3	1	0	3	50	50	100
23-204 -07**	Professional Elective - III	3	1	0	3	50	50	100
23-204 -07**	Open Elective - I	3	0	0	3	50	50	100
23-204 -0712	Computer Graphics Laboratory	0	0	3	1	25	25	50
23-204 -0713	Mini Project – Multimedia Project	0	0	3	1	25	25	50
23-204 -0714	Entrepreneurship Development	0	0	2	1	50	-	50
23-204 -0715	Project Phase I	0	0	3	2	50	-	50
23-204 -0716	Internship-III	0	0	0	1	50	-	50
	TOTAL	**15**	**4**	**11**	**21**			
Minor in Information Technology								
23-204-0717	Mini Project: Cloud Computing Project for Big Data Analytics	0	0	3	3	100	0	100
Honours in Information Technology								
23-204-718#	MOOC Broad Area: AI Ethics	0	0	0	3	0	0	100

Internship-III of a minimum duration of two weeks (10 working days) after VI semester and the evaluation will take place during the VII semester.

#Students should take Massive Open Online Courses(MOOCs) approved by the concerned Division/Board of Studies(BoS)

23-204-0704 to 23-204-0707 PROFESSIONAL ELECTIVE – III	
Code No.	**Subject**
23-204 -0704 (IE)	Industrial Management
23-204 -0705	Generative AI
23-204 -0706	Quantum Computing
23-204 -0707	Prompt Engineering

23-204-0708 to 23-204-0711 OPEN ELECTIVE – I	
Code No.	**Subject**
23-204 -0708	Educational Technology
23-204 -0709	Game Design
23-204 -0710	Multimedia Computing
23-204-0711	Web Mining

SEMESTER VIII- Regular Track

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-204-08**	Professional Elective - IV	3	1	0	3	50	50	100
23-204-08**	Professional Elective - V	3	1	0	3	50	50	100
23-204-08**	Professional Elective - VI	3	1	0	3	50	50	100
23-204-08**	Open Elective - II	3	0	0	3	50	50	100
23-204-0818	Seminar	0	0	3	1	50	-	50
23-204-0819	Project Phase - II	0	0	12	6	200	-	200
23-204-0820	Comprehensive Viva Voce	0	0	0	1	-	50	50
	TOTAL	**12**	**3**	**15**	**20**			

SEMESTER VIII- Internship Track*

Code No.	Subject	L H/ W	T H/ W	P/D H/W	C	Marks		Total
						CA	SEE	
23-204-08**	Professional Elective - IV	3	1	0	3	50	50	100
23-204-08**	Elective (Professional /Open)	3	1	0	3	50	50	100
23-204-0818	Seminar	0	0	2	1	50	-	50
23-204-0819	Project Phase - II	0	0	12	6	200	-	200
23-204-0820	Comprehensive Viva Voce	0	0	0	1	-	50	50
23-204-0821	Internship-IV	0	0	0	6	200		200
	TOTAL	**6**	**2**	**14**	**20**			

23-204-0801 to 0804 PROFESSIONAL ELECTIVE -IV	
Code No.	**Subject**
23-204-0801	Block Chain Technology
23-204-0802(IE)	Robotic Process Automation
23-204-0803	Patents and Intellectual Property Rights
23-204-0804	Cyber Laws and Information Security

23-204-0805 to 0808 PROFESSIONAL ELECTIVE -V	
Code No.	**Subject**
23-204-0805	Software Quality and Testing
23-204-0806	Electronic Business and Services
23-204-0807	Research Methodology
23-204-0808	Cognitive Computing

23-204-0809 to 0812 PROFESSIONAL ELECTIVE -VI	
Code No.	**Subject**
23-204-0809	Digital Twin Technology
23-204-0810	Wireless Networking
23-204-0811	Computer Vision and Transformers
23-204-0812	Real Time System

23-204-0813 to 0816 & 23-200-0817 OPEN ELECTIVE – II	
Code No.	**Subject**
23-204-0813	Software Project Management
23-204-0814	Social Computing
23-204-0815	Ethical Hackings
23-204-0816	ARM Processor Technology
23-200-0817*	Constitutional Law

*Common to all branches

List of Minor Courses (Data Engineering)

Code No.	Subject	L	T	P/ D	C	Marks		Total Marks	Offering semester	Mode of learning
						CA	SEE			
23-204-0310	Foundations of Data Management and Structures.	3	1	0	3	50	50	100	III	Class room
23-204-0311	MOOC1 Broad Area: Web Designing Technologies	0	0	0	3	0	0	100	III	Online/ offline
23-204-0410	MOOC2: Broad Area: Introduction to Data Communications and Networking	0	0	0	3	0	0	100	IV	Online/ offline
23-204-0513	Big Data Analytics and Machine Learning	3	1	0	3	50	50	100	V	Classroom
23-204-0612	MOOC3 Broad Area: Cloud Computing	0	0	0	3	0	0	100	VI	Online/ offline
23-204-0717	Mini Project: Cloud Computing Project for Big Data Analytics	0	0	3	3	100	0	100	VII	

List of Courses for Honours

Code No.	Subject	L	T	P/ D	C	Marks		Total Marks	Offering semester	Mode of learning
						CA	SEE			
23-204-411	Computational Thinking	3	1	0	3	50	50	100	IV	Classroom
23-204-514	Research Methodology and Intellectual Property Rights	3	1	0	3	50	50	100	V	Classroom
23-204-515	MOOC 1 Broad Area: Data Engineering and Analytics	0	0	0	3	0	0	100	V	Online/ classroom
23-204-613	Optimization Techniques	3	1	0	3	50	50	100	VI	Classroom
23-204-614	MOOC 2 Broad Area: Business AI	0	0	0	3	0	0	100	VI	Online/ classroom
23-204-718	MOOC 3 Broad Area: AI Ethics	0	0	0	3	0	0	100	VII	Online/ classroom

Industry Based Electives

Industry-based Electives are offered in the 5th, 6th and 7th Semesters and listed among the Professional Electives with the notation (IE) and the subject code. A student should opt for at least one Industry-based elective during the B. Tech programme.

Open Electives

Open Electives are offered in the 7th and 8th Semesters. A student should opt for at least one Open Elective offered by any Division/Department other than their branch of study.

MOOC

Every student shall undergo at least one MOOC of minimum 12 weeks duration during the programme (preferably before the final semester) as per the university Regulations for conducting online courses (MOOC).

SEMESTER VIII Internship Track

Students who intend to go for the Internship Track should inform the division head concerned before the commencement of the 8th Semester. The student will be given the option to change the track within 30 days from the commencement of the 8th Semester. Students opting for the Internship Track have to do Project Phase II and appear for the Comprehensive Viva-Voce.

The interns may opt for courses recommended by the division from the list of NPTEL/SWAYAM courses approved by the BoS.

The students opting for the divisional courses must fulfil the Continuous Assessment (CA) and Semester End Examination (SEE) requirements.

One elective from the Open Elective pool is mandatory if they have not completed one mandatory Open Elective in the seventh semester.

Project Phase II is the continuation of Project Phase I in the seventh semester or a separate one if approved by the division.

The Internship-IV is of a minimum six weeks duration, must be done in an Industry approved by either the Placement Cell or the respective Department based on a valid MOU or in any government/organization approved by the division.
The Internship-IV is equivalent to two 3-credit courses for a total of 200 marks.
The progress of Internship-IV will be evaluated twice during the semester, along with the Continuous Assessment tests and finally after the completion of the internship.

EVALUATION PATTERN FOR THEORY AND PRACTICAL COURSES

1. Theory Courses

Types of questions for Semester End Examination (SEE)

Part A $(\mathbf{5 \times 2 = 10}\ \boldsymbol{marks})$
Question No. I (a) to (e) – Five short answer questions of 2 marks each with at least one question from each of the four modules.

Part B $(\mathbf{4 \times 10 = 40}\ \boldsymbol{marks})$
Questions nos. II, III (from Module I) of 10 marks each with the option to answer either II or III. The questions may have sub-sections (a) and (b)
Questions nos. IV, V (from Module II) of 10 marks each with the option to answer either IV or V. The questions may have sub-sections (a) and (b)
Questions nos. VI, VII (from Module III) of 10 marks each with the option to answer either VI or VII. The questions may have sub-sections (a) and (b)
Questions nos. VIII, IX (from Module IV) of 10 marks each with the option to answer either VIII or IX. The questions may have sub-sections (a) and (b)

2. Practical Courses

50% of marks are earmarked for Continuous Evaluation, and 50% of marks are for Semester End Examination. A minimum of two examiners will conduct the semester-end examination.

Pass Requirements

A candidate has to obtain a minimum of 50% marks for Continuous Assessment and Semester End Examination, put together with a minimum of 40% marks in the Semester End Examination for a pass in theory and laboratory courses.

In the case of theory/laboratory/other courses having only Continuous Assessment, a candidate has to obtain a minimum of 50% marks in Continuous Assessment for a pass.

SEMESTER I

23-200-0101B CALCULUS

Course Outcomes:

On completion of this course the student will be able to:

1. Solve ordinary differential equations and linear differential equations of higher orders with constant coefficient and apply them in engineering problems
2. Determine the maxima and minima of multi variable functions.
3. Convert line integrals into surface integrals and surface integrals into volume integrals
4. Illustrate the physical meaning and application of gradient, divergence and curl

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Ordinary differential equations:
First order differential equations - exact differential equations, Bernoulli's equations--Methods of solution and Simple applications.
Linear differential equations of higher orders with constant co-efficient-Methods of solution of these equations. Cauchy's linear differential equations. Simultaneous linear differential equations- Simple applications of linear differential equations in engineering problems –Electrical Circuits, Mechanical Systems.

Module II

Partial differentiation: Partial Differentiation-Concept of partial derivative - Chain rule- Total derivative- Euler's theorem for homogeneous functions, Differentials and their applications in errors and approximations, Jacobians - Maxima minima of functions of two variables (Proof of the result not required)-Simple applications.
Co-ordinate systems: Rectangular co-ordinates-Polar co-ordinates-In plane and in Space-Cylindrical polar co-ordinates-Spherical polar co-ordinates.

Module III

Integral calculus:
Application of definite integrals: Area, Volume, Arc length, Surface area.
Multiple integral: Evaluation of double integrals-Change of order of integration. Evaluation of triple integrals-Change of Variables in integrals.
Applications of multiple integrals. Plane Area, Surface area & Volumes of solids

Module IV

Vector calculus: scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of vector point functions, their physical meaning. Evaluation of
line integral, surface integral, and volume integrals, Gauss's divergence theorem, Stoke's theorem (No proofs), conservative force fields, scalar potential. Note: Implement case study as assignments.

References:

1. Sastry, S.S. Engineering Mathematics: Vol1. (Fourth edition). PHI Learning, New Delhi. (2008).
2. Erwin Kreyzig. Advanced Engineering Mathematics (Tenth edition). John Wiley& Sons, Hoboken, NJ. (2011)
3. Veerarajan, T. Engineering Mathematics. (Third edition). Tata McGraw Hill Publishers, New Delhi. (2011)
4. Grewal, B.S. Higher Engineering Mathematics. (Forty third Edition). Khanna Publishers, New Delhi. (2013).

23-200-0102B ENGINEERING PHYSICS

Course Outcomes:

On completion of this course the student will be able to:

1. Interpret modern devices and technologies based on lasers and optical fibres.
2. Explain the basic principles of crystal physics
3. Summarise the characteristics and applications superconducting materials nanomaterials and smart materials
4. Illustrate the theory of semiconductors and magnetic materials
5. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Laser-properties-interaction of radiation with matter-absorption, spontaneous and stimulated emission-principle of laser--Einstein coefficients- population inversion- metastable state -Basic components of a laser- construction and working of Ruby laser and He-Ne laser -Applications.

Fibre optics - Basic structure - principle- step-index fibre and graded index fibre- single mode and multimode- Numerical aperture (no derivation) -acceptance angle and acceptance cone-propagation- Applications.

Module II

Crystallography – Space lattice- Basis- Unit cell-Bravais lattices- cubic lattices-sc, bcc, and fcc- Number of atoms per unit cell- Coordination number- Atomic Radius-Packing factor- Relation between density and crystal lattice constants-Lattice planes and Miller indices-

X rays- Production, Properties, characteristic and continuous X-rays, Moseley's law; Diffraction of X-rays- Bragg's law (derivation), Bragg's Spectrometer

Module III

Superconductor-transition temperature-Meissner effect-effect of current- isotope effect- Type 1 and type 2 superconductors –BCS theory (basic idea only)- Applications.

Nanomaterials- nanoparticle, nano ring, nano rod, nanoshells, fullerene- surface occupancy-quantum confinement effect-optical, electrical, magnetic and mechanical properties - Applications.

Smart materials-Liquid crystals, Metallic glasses, Shape memory alloys- optical, electrical magnetic and mechanical properties-applications

Module IV

Magnetic Materials-Magnetic pole strength, magnetic moment, intensity of magnetization, magnetic field, magnetic induction, magnetic susceptibility, magnetic permeability, classification. Hard and soft- Paramagnetic materials-properties, Diamagnetic materials-properties, Ferromagnetic properties- Antiferromagnetic materials, Ferrimagnetic materials- Applications

Semiconductor-Properties-Energy band description-effect of temperature-intrinsic, extrinsic semiconductors-n-type and p-type semiconductors-Majority and minority carriers.

Laboratory Experiments to be conducted in the virtual lab mode.

List of Experiments (Minimum six experiments shall be conducted)

1. Transmission grating: To find the wavelength of laser beam
2. Determination of NA of an optical fibre
3. Laser beam divergence and spot size
4. Determination of Grain size and lattice parameter using Bragg's X-ray spectrum
5. Lattice planes from X Y Z intercepts
6. LCR circuits to find the resonance frequency and quality factor.
7. Diode characteristics
8. Ohm's law
9. LED circuits to find cutting voltage.
10. Determination of Energy band gap of a given semiconductor material
11. Magnetic field along the axis of a circular coil carrying current
12. Deflection Magnetometer

References:

1. S. Mani Naidu, A Textbook of Engineering Physics, Pearson. (2010)
2. A.S. Vasudeva, Modern Engineering Physics, S. Chand & Co. (2013)
3. Prabir K. Vasu and Hrishikesh Dhasmana, Engineering Physics, Ane books Pvt. Ltd. (2010)
4. S.O. Pillai and Sivakami, Applied Physics, New Age International (P) Ltd., Second Edition. (2008)
5. G.S. Raghuvanshi, Engineering Physics, Prentice Hall of India. (2008)

Pattern of Continuous Assessment

Test -I for the theory portions	:	15 marks
Test -II for the theory portions	:	15 marks
Assignment from the Theory	:	05 marks
Laboratory Record	:	05 marks
Viva-voce	:	05 marks
Attendance	:	05 marks
TOTAL	**:**	**50 marks**

The students are required to submit the laboratory record.

23-200-0103B INTRODUCTION TO ELECTRONICS DEVICES & CIRCUITS

Course Outcomes:

On completion of this course the student will be able to:

1. To understand the working principle of various semiconductor devices
2. To apply the acquired knowledge to the use of semiconductor devices in various applications.
3. To design simple electronic circuits for a given application.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Semiconductor basics. PN junction diode and its characteristics, Diode Models Diode Applications: Rectifiers- Half wave and full wave rectifiers, Capacitive Filter Clipping and clamping circuits, Special purpose diode: Zener Diode, LED, Photo diode; Zener Shunt, Transistor series regulator

Module II

Bipolar Junction Transistors (BJT): Transistor Structure, Transistor operation, Transistor characteristics (CE & CB only) and alpha & beta Parameters, r parameter model, h parameter Transistor as an amplifier, Transistor bias circuits: DC operating point, load line, stabilization, Voltage divider bias, Thermal runaway. Transistor switch. FET, FET characteristics.

Module III

Amplifiers: classification of amplifiers as Voltage, Current, transconductance & transresistance amplifiers-properties, operation, CB, CC & CE Amplifiers, bypass and coupling capacitor, common emitter Amplifier, Amplifier Frequency Response: Basic concepts, Low frequency and High frequency response cutoff Total Amplifier frequency Response. FET amplifier (CS configuration only), Multistage amplifier (qualitative study).

Module IV

Feedback in amplifier, benefits of feedback, positive & negative feedback (qualitative study). Oscillator: RC phase shift oscillator, circuit & it's working. LC oscillator Multivibrator: astable multi vibrator, circuit & its working. Bistable multi vibrators, circuit & it's working. bistable as memory.

References:

1. David M. Buchla, Thomas L. Floyd, Electronics Pearson Education Limited, Year: 2014
2. K V Ramanan, Functional Electronics, Tata McGraw-Hill Publishing Company Ltd. (1984).
3. Donald Neamen, Semiconductor Physics and Devices, Tata McGraw-Hill Publishing Company Ltd., 4th edition (2021).
4. Jacob Milman & Christos C Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, McGraw Hill Education, 2 nd edition (2017).

23-200-104B INTRODUCTION TO ELECTRICAL ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Apply elementary principles for finding the DC response of Circuits.
2. Develop & solve models of basic magnetic & electromagnetic circuits.
3. Apply elementary principles for finding the sinusoidal steady state features of Circuits.
4. Familiarize with the basic engineering principles of some common electrical systems.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Elementary Concepts of Electric Circuits Elementary concepts of DC electric circuits: Basic Terminology including voltage, current, power, resistance, emf; concept of linear, non linear, unilateral, bilateral, active & passive circuit elements, independent voltage & current sources, Interconnection of Resistances- series, parallel, series-parallel, star & delta interconnection, Star-delta/delta-star transformation ; Current and Voltage Division Rules; Capacitance: Parallel plate capacitance with single dielectric, V-I relations and energy stored, Capacitances in series, parallel & series-parallel; Ohm's Law and Kirchhoff's laws-Problems.

Introduction to Dynamic Circuits: DC Sourced & Source free Response of RC series circuit, Time Constant, Concept of transient & steady state components of response.

Module II

Elementary Concepts of Magnetic & Electromagnetic Circuits, and AC fundamentals: Magnetic Circuits: MMF, field strength, flux density, reluctance - comparison between electric and magnetic circuits- Series and parallel magnetic circuits with composite materials, numerical problems.

Electromagnetic Induction: Faraday's laws, Lenz's law- statically induced and dynamically induced emfs, conductor moving in a uniform magnetic field, Self-inductance and mutual inductance, coefficient of coupling, V-I relations of self & mutual inductance, Two winding Transformer, Basic Transformer Equation connecting voltages, currents & number of turns, energy stored in a coupled coil system, Series Connection of coupled Inductances.

Alternating Current fundamentals: Representation of sinusoidal waveforms: frequency, period, cycle, phase, Average, RMS values and form factor of waveforms-Numerical Problems.

Module III

Sinusoidal Steady State Response: Sinusoidal Steady Response of Basic Elements: Phasor Representation of sinusoidal quantities, Trigonometric, Rectangular, Polar and complex forms, Response of basic R, L and C elements to a sinusoidal voltage or current –Phasor diagrams, Average power and power factor-Numerical Problems.

Series and Parallel AC Circuits: Reactances, Impedance, Admittance, Solution of series, parallel & series-parallel AC circuits, Power in AC circuits: active, reactive & apparent powers-Numerical Problems, Resonance in series and parallel circuits, Frequency dependance of impedance and admittance, frequency response function & frequency response plots, half power/cut off frequency, bandwidth

Three phase AC systems: Star and delta connected balanced three phase systems, Phasor diagram, relation between line and phase voltages, line and phase currents, active, reactive & apparent powers-Numerical problems.

Module IV

Applications: Dynamic Circuits: Use of simple first & second order resonant/non resonant RLC circuits as low pass, high pass, band pass & band stop filters, RC Differentiator & Integrator

Power Circuits of domestic/Daily Use Appliances: Concept of Linear & non linear AC loads, very basic concept of Power Quality, Functional Block Diagram of the power circuit of modern domestic/daily use appliances-LED Lamps & Tubes, BLDC Fans, Mobile & Laptop Chargers, Inverter Air Conditioner & Inverter Refrigerator, Need & methods of galvanic isolation.

Rechargeable Batteries: Basic Terminology, Battery Capacity, SOC, SOE, SOH DOD, C-rate, Cycle Life, Cut off

voltage, deep cycle, Charging Profile, self discharge, Energy Density, Power density, Specific Energy, Specific Power, Purpose & Functions of BMS.
UPS: Functional block diagram, Specifications and Applications of online & offline UPS, computation of back up time.
Power Systems: Various levels of Power Transmission/Distribution- Typical Single line diagram.

References:

1. Edward Hughes. Electrical technology. Pearson Education 8th ed. 2002.
2. Robert L. Boylestad. Introductory circuit analysis. Pearson Education, 14th edition 2022
3. Cotton, H. Electrical technology. CBS Publishers and Distributors, New Delhi. 7th edition
4. Leonard S. Bobrow. Fundamentals of electrical engineering. Oxford University Press. second edition, 1996

23-200-0105B COMPUTER PROGRAMMING

Course Outcomes:

On completion of this course the student will be able to:

1. Identify main components of a computer system and explain its working.
2. Develop flowchart and algorithms for computational problems.
3. Write the syntax of various constructs of C language.
4. Build efficient programs by choosing appropriate decision-making statements, loops and data structures.
5. Design modular programs using functions for larger problems

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Basics of Computer and Information Technology: Digital Computer System (CPU, Memory, I/O devices)- Working of a digital computer-Hardware and Software: Definition - Categories of Software, Application of Computers.
Problem Solving Methodology: Problem statement, Analysis, design a solution, Implement/Coding the solution, Test the solution, Design tools (Algorithm, Flow-chart, Pseudo-code)- Develop algorithms for simple problems.
Programming Languages: Types of Languages-Compiler–Interpreter-Linker–Loader– Execution of program.

Module II

Basics of C: Character set-Identifier- Keywords- Constants –Data Types- Variables and declaration –Operators and Expressions – Operator precedence and associativity – Expression Evaluation (Simple Examples) - Input and output functions – Simple computational problems involving the above constructs.
Control Statements: Selection, Conditional operator, Iteration (for, while, do-while), Branching (switch, break, continue, goto), Nesting of control statements- Problems using control statements.

Module III

Arrays: One-dimensional array: Declaration, Initializing and Accessing of Array, Operations with Array, Internal Representation of Array, Working with One-dimensional Array (searching and sorting).
Multi-dimensional array: Declaration, Initializing and Accessing of Array, Working with Two-dimensional Arrays with Matrix.
Strings: Declaration, Initialization and Accessing of String, String Functions, Working with One-dimensional character Array and String Functions.
Functions: Concept of Function, Using Function (Declaration, Definition and Calling), Parameter Passing in C, Inline Function, Recursion, Working with Functions.

Module IV

User defined data types: Structure, Union & Enumerated data type- Declaration, Initialization and Accessing of Structure, Union & Enumerated Data types, Structure versus Union, Arrays of Structure, Working with Structures.
Pointers: Declaration, Initialization & Accessing Pointer– Use of Pointers, Pointer Arithmetic, Arrays and Pointers, Structures and Pointers, Working with Pointers (Pointers to Array:
One-dimensional arrays and pointers, Passing an array to a function), Dynamic memory allocation. Command line arguments.

References:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming, Second Edition, Oxford University Press, (2013).
2. Byron Gottfried, Programming with C, Fourth edition, Tata McGraw-Hill, (2018).
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2015).
4. R.G. Dromey, How to solve it by Computer, Pearson Education, (2008).
5. Kanetkar Y, Let Us C: Authentic guide to C programming language (18th Edition), BPB Publications, (2021)

23-200-0106B SOFT SKILLS DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Use English language at the formal and informal levels for daily conversation, presentation, group discussion and debate.
2. Demonstrate the ability to read, comprehend and answer questions based on literary, scientific and technological texts
3. Develop self-motivation, raised aspiration, belief in one's own abilities and commitment to achieving one's goal
4. Demonstrate emotional maturity and emotional health.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations

Module II

Fundamental grammar, Simple structures, passivating the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open – ended and close- ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing and good netiquette. Writing for internships and scholarships.

Module III

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming and activities on the same.

Different types of interviews, and presentations - oral, poster, ppt. Organizing ideas for group discussions, the difference between GD and debates.

Effective listening and seeking to understand others' perspectives. Non-violent negotiation and persuasion, communicating across age groups, cultures or identity groups.

Higher order thinking and evaluation, information-seeking, research, and independent learning, synthesis, creativity, problem analysis and problem solving. Decision making, Self-reflection and learning from experience.

Module IV

Developing positive self: Understanding oneself, A realistic awareness of oneself and one's abilities, strengths and potential, Self-esteem, Self-efficacy, steps for improvement.

Intra-personal skills – Self-control, emotional regulation and self-discipline, conscientiousness, dutifulness, reliability, truthfulness, honesty and trustworthiness. Goal orientation and initiative. Time management – prioritising work.

Interpersonal skills – cross cultural competence and valuing diversity of perspectives, respecting and expressing concern for others. Empathy and ability to notice the effect of one's actions on others, tolerance for disagreement, conflict management and resolution.

Civic engagement and social responsibility – Global and local awareness (issues, challenges, priorities). Vision, ability to imagine something new or improved. Social responsibility and willingness to take constructive action.

References:

1. Duck, Steve and David T. Macmahan. Communication in Everyday Life. 3rd Ed. Sage, (2017).
2. Gamble, Kawl Teri and Michael W. Gamble. The Public Speaking Playbook. Sage, (2015).
3. Raman, Meenakshi and Sangeetha Sharma. Technical Communication: Principles and Practice, Oxford University Press, (2015).
4. Coleman, D. Emotional intelligence: Why it can matter more than IQ, Bantam Books, New York (2006).
5. Devadas Menon. Stop sleepwalking through life, Yogi Impressions Books Pvt. Ltd, Mumbai (2012).
6. Barun K Mitra. Personality Development and Soft Skills, Oxford University Press (2012).

Assessment

- 'Soft Skills Development' is a practical and activity-oriented course which has continuous assessment for 50 marks based on classroom interaction, activities, and assignments. The activities may include 'Just a Minute' (JAM) sessions, group discussion, role play, debate, and extempore speech.
- The weightages for the different components shall be as follows:
  - Classroom interaction – 10 marks
  - Activities – 30 marks
  - Assignments (from Modules I and II) – 10 marks
  - Semester End Examination is not envisaged.
- A student should secure a minimum of 50% marks in continuous assessment for a pass in the course.

23-200-0107B COMPUTER PROGRAMMING LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Write programs using loops and decision-making statements in C language.
2. Implement different operations on arrays.
3. Solve problems using functions and recursion.
4. Design and implement C programs using the concepts of structure and pointers.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Cycle I

- Application Packages:
  - Text Editor
    - To create a word document like an advertisement.
  - Spreadsheet
    - To create a spreadsheet to analyse the marks of the students of a class and also to create appropriate charts.
  - Presentation Software
    - To create a presentation for the department using MS PowerPoint.
- C Programming Basics:
  - To write a program to calculate and display areas of rectangle and triangle.
  - Decision Making:
    - To write a program for electricity bill preparation.
    - To write a program to find the roots of a quadratic equation.
    - To write a simple menu driven calculator program using switch statements.
    - To write a program to find the sum of digits of a given number.

Cycle II

- Looping:
  - To write a program to print all the prime numbers of a given range.
  - To write a program to print the sine and cosine series.
  - To write a program to print Pascal's triangle.
- Arrays:
  - To write a program to print the sum and average of elements in an array.
  - To write a program to sort the given numbers using bubble sort.
  - To write a program to perform Matrix addition and matrix multiplication.
- String:
  - To write a program to perform string manipulation functions like string concatenations, comparison, find the length and string copy without using library functions.
  - To write a program to arrange names in alphabetical order.

Cycle III

- Functions:
  - To write a C program to calculate the mean, variance and standard deviation using functions.
  - To write a C program to perform sequential and binary search using functions.
- Recursion:
  - To write a program to print the Fibonacci series using a recursive function.
  - To write a program to print the factorial of the given number using a recursive function.
- Structure:
  - To print the mark sheet of N students using structures.
- Pointers:

- To write a program using pointers to access the elements of an array and count the number of occurrences of the given number in the array.

References:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming in C, Second Edition, Oxford University Press, (2013).
2. Smarajit Ghosh, All of C, PHI Learning Pvt. Ltd, (2009).
3. Byron Gottfried, Programming with C, Fourth edition, Tata McGraw-Hill, (2018).
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2015).
5. Sukhendu Dey, Debobrata Dutta, Complete Knowledge in C, Narosa Publishing House, New Delhi, (2013).
6. R.G. Dromey, How to solve it by Computer, Pearson Education, (2008).
7. Kanetkar Y, Let Us C: Authentic guide to C programming language (18th Edition), BPB Publications, (2021).

23-200-108B ELECTRICAL ENGINEERING LAB

Course Outcomes:

On completion of this course the student will be able to:

1. Identify & choose appropriate apparatus for ON-OFF Control, protection diagnosis & instrumentation of a typical LV electrical appliance/circuit.
2. Familiarize with various types of electric motors and conventional & smart electrical systems.
3. Familiarize with the electrical characteristics of common appliances & solar panels.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Details of Experiments

1. Familiarization with various electrical apparatus like switches, relays, smart plugs, smart switches, conventional to smart switch converters, AC & DC Voltmeter, AC & DC Ammeter, Multimeter, Wattmeter, Energy meter, fuse, MCB, Isolator, RCB, ELCB, RCBO
2. Verification of Ohm's Law & Kirchoff's Laws for both DC & AC circuits.
3. Domestic Wiring Circuits with one way/two-way switches & plug point.
4. Experimental determination of V-I characteristics, MPP & predetermination of operating point of a solar panel for resistive load.
5. Measurement of Current, Power, Power Factor & Energy of:
    a. A single-phase circuit with known parameters
    b. Various domestic/daily use appliances like LED Lamps, LED Tubes, Ceiling fans, Laptop, LED Display, PC+LED Display.
6. Experimental/Simulation based study of an RLC series Circuit under resonant & non-resonant conditions.
7. Experimental determination of frequency Response of Circuits.
8. Familiarization with various types of Electrical Machines
9. Experiment on Automatic Street Lighting System.
10. Experiments on Home Automation.

23-200-0109B LANGUAGE LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Test pronunciation skills through stress on word accent, intonation, and rhythm.
2. Use the English language effectively for writing business letters, resumes, minutes of meetings and reports.
3. Use the English language effectively to face interviews, group discussions, and public speaking.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									2	3		2
CO2									2	3		2
CO3									2	3		2

1-Slightly**; 2**-Moderately**; 3**-Substantially

The following exercises are prescribed for the Language Laboratory sessions:

1. Introduction to the Sounds of English- Vowels, Diphthongs & Consonants.
2. Introduction to Stress and Intonation.
3. Preparing business letters
4. Preparing a resume
5. Conducting a meeting and writing the minutes
6. Writing a report
7. Situational Dialogues / Role Play.
8. Oral Presentations- Prepared and Extempore.
9. 'Just A Minute' Sessions (JAM).
10. Describing Objects / Situations / People.
11. Debate
12. Group discussion

23-200-0110B NSS/NATURE CONSERVATION ACTIVITIES/YOGA

NATIONAL SERVICE SCHEME (NSS)

Course Outcomes:

On completion of this course the student will be able to:

1. Identify the community in which they work
2. Utilise their knowledge in finding practical solutions to individual and community problems.

A student enrolling as a member of NSS will have to complete 10 hours of training / social service.

NATURE CONSERVATION ACTIVITIES

Course Outcomes:

On completion of this course the student will be able to:

1. Demonstrate the message of sustainable lifestyles.
2. Explain the importance of green plants in mitigating global environmental problems.
3. Identify suitable waste management practices for the local community.

A student enrolling as a member of the Nature Conservation Club will have to complete 10 hours of campus cleaning and greening activities.

YOGA

Course Outcomes:

On completion of this course the student will be able to:

1. Demonstrate the use of yoga for stress management.
2. Illustrate the different yogic postures for physical and mental wellbeing.
3. Identify suitable methods of strengthening physical, emotional, intellectual aspects of "self" based on the principles and practices of Yoga and positive psychology.

.

SEMESTER II

23-200-0201B LINEAR ALGEBRA & TRANSFORM TECHNIQUES

Course Outcomes:

On completion of this course the student will be able to:

1. Solve linear systems of equations and to determine Eigen values and vectors of a matrix.
2. Exemplify the concept of vector space and subspace.
3. Determine Fourier series expansion of functions and transform.
4. Solve linear differential equation and integral equation using Laplace transform.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Linear Algebra 1: Rank of a matrix, solution of linear system of equations- existence, uniqueness, general form-Eigen values and Eigen vectors- properties of Eigen values - Diagonalization of a matrix - Cayley Hamilton theorem (without proof) Verification-Finding inverse and power of a matrix using it-Quadratic form-orthogonal reduction of quadratic form to Canonical form.

Module II

Linear Algebra 2: Vector space-subspace-Linear dependence and independence-Spanning of a subspace- Basis and Dimension. Inner product- Inner product spaces - Orthogonal and Orthonormal basis
–Gram- Schmidt Orthogonalization process. Linear Transformation.

Module III

Fourier Analysis: Periodic function, Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansion, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier Cosine and Sine Transform, Fourier Transform.

Module IV

Laplace Transforms: Gamma functions and Beta function-Definition and properties, Laplace transforms. Inverse Laplace Transform, Shifting theorem, Transform of Derivative and Integrals, Solution of differential equation and integral equation using Laplace transform, Convolution, Unit step function, Second Shifting theorem, Laplace transform of periodic function.

References:

1. Erwin Kreyzig. (2010). Advanced engineering mathematics. (tenth edition). John Wiley & Sons, Hoboken, N.J
2. Grewal, B.S. (2013). Higher engineering mathematics. (forty third edition). Khanna Publishers, New Delhi.
3. Hsiung,C.Y and Mao, G. Y. (1999). Linear algebra. World Scientific, New Jersey.
4. Hoffman, K. and Kunze, R. (1971). Linear algebra. Prentice Hall of India, New Delhi.
5. Venkataraman, M. K. (1999). Linear algebra. The National Publishing Co, Chennai.

23-200-0202B ENGINEERING CHEMISTRY

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the basic concepts of chemical thermodynamics, and quantum chemistry.
2. Illustrate the spectroscopic methods in characterizing materials.
3. Develop electrochemical methods to protect different metals from corrosion.
4. Interpret the chemistry of a few important engineering materials and their industrial applications.
5. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Chemical Thermodynamics: Fundamentals. First law of thermodynamics, Molecular interpretation of internal energy, enthalpy and entropy. Heat of reaction. Kirchoff's equations. Dependence on pressure and temperature. Gibbs-Helmholtz equation. Free energy changes and equilibrium constant. Chemical potential and fugacity. Thermodynamics of biochemical reactions.

Phase Rule: Terms involved in phase rule and examples, Application of phase rule to one component water system, Application of phase rule to two-component systems. (Simple eutectic systems).

Module II

Quantum Chemistry: Schrodinger wave equation – significance of Ψ, well behaved functions, Postulates of quantum mechanics, Application of quantum mechanics to simple systems - particle in 1 D box, normalization of wave function, Forms of hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Quantum numbers.

Module III

Spectroscopy: Principles of spectroscopy and selection rules. Electronic spectroscopy. Vibrational and rotational spectroscopy of diatomic molecules. Applications.

1H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting - coupling constant - applications of NMR- MRI.

Module IV

Electrochemistry: Cell EMF- its measurement and applications. Nernst Equation and application, relation of e.m.f. with thermodynamic functions (ΔH, ΔF and Δ S). Lead storage battery. Corrosion; causes, effects and its prevention.

Polymers- Classifications- Thermoplastics and thermosetting plastics- A brief account of conducting polymers (polypyrrole and polythiophene) and their applications.

Lubricants- Introduction solid and liquid lubricants- Properties of lubricants-Viscosity index- flash and fire point- cloud and pour point- aniline value.

Refractories: Classifications – Properties of refractories.

Laboratory Experiments to be conducted in the virtual lab mode.

List of Experiments (Minimum six experiments shall be conducted)

1. Determination of the partition coefficient of a solute in two immiscible liquids.
2. Phase diagram of two component System (Naphthalene-diphenylamine)
3. Conductometric titration of Strong acids with Strong base.
4. Potentiometric titration: Fe2+ vs KMNO4

5. Heat of neutralization
6. Verification of Beer-Lambert's law
7. Determination of rate constant of a reaction.
8. Determination of total hardness of water by EDTA method.
9. Determination of COD of water sample.
10. Determination of alkalinity of water.
11. Determination of chloride content of water by Mohr's method.
12. Determination of dissolved oxygen in a given water sample.
13. Determination of acidity of water sample.
14. Determination of adsorption of acetic acid by charcoal.
15. Determination of acidity of water sample

References:

1. B. H. Mahan and R. J. Meyers. University Chemistry, 4th Edition, Pearson publishers. (2009).
2. Peter W. Atkins, Julio de Paula, and James Keele. Physical Chemistry, 11th Edition, Oxford publishers. (2018).
3. M. J. Sienko and R. A. Plane. Chemistry: Principles and Applications, 3rd Edition, McGraw-Hill Publishers. (1980).
4. C. N. Banwell. Fundamentals of Molecular Spectroscopy, 5th Edition, McGraw-Hill Publishers. (2013).
5. B.L. Tembe, M.S. Krishnan and Kamaluddin. Engineering Chemistry (NPTEL Web Course).
6. Shashi Chawla. A Textbook of Engineering Chemistry. Dhanpat Rai & Co, New Delhi.(2013).

Pattern of Continuous Assessment

Test -I for the theory portions	:	15 marks
Test -II for the theory portions	:	15 marks
Assignment from the Theory	:	05 marks
Laboratory Record	:	05 marks
Viva-voce	:	05 marks
Attendance	:	05 marks
TOTAL	**:**	**50 marks**

The students are required to submit the laboratory record.

23-200-0203B DIGITAL ELECTRONICS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental boolean functions and basic building blocks of Digital systems
2. Design Optimal digital circuits using basic building blocks
3. Analyse Basic digital circuits
4. Understand HDL models of simple circuits

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Digital Concepts and Techniques: Binary arithmetic, Binary coded Decimal, Excess - 3 code, Gray Code. Boolean algebra-Standard Sum of products, Standard Product of sums. Logic gates. Minimization of Boolean function :Karnaugh Map (up to 5 variables) and Quine - McClusky methods. Variable entered mapping. Design of optimal logic function from a given problem statement.
HDL: Basic concepts and modelling of simple circuits.

Module II

Combinational circuits: Half adder, Full adder, Subtractor, Ripple Carry adder, Carry look ahead adder, BCD adder, multiplexer, demultiplexer, Basic decoder and encoder circuits,Binary Multiplication.
Sequential circuits: Flip-flops – (RS /JK / MS/T / D)
Serial Adder-Difference between Parallel Adder and Serial Adder
HDL: Models of simple combinational circuits

Module III

Shift Registers: various types - Counters : Asynchronous and synchronous counters, Up-Down counter, Shift Register Counters - Sequence generators
HDL: Models of simple sequential circuits.

Module IV

Implementation of logic functions using PLA, PROM. Error Detection and Correction: Parity, (7,4) Hamming code. Practical design considerations: Logic families- Standard logic levels- Current And Voltage Parameters- fan in and fan out-Propagation delay, Noise margin, Speed power product, setup time, hold time.
TTL family NAND gate working principle, Totem pole configuration- Transfer characteristics, Tri-state logic gate.
Note*: HDL portion of each module to be evaluated based on assignments ONLY, as part of Continuous Evaluation, subject to a maximum weightage of 50% of marks allocated for assignments*

References:

1. Floyd, Thomas L. Digital fundamentals, 11/e. Pearson Education India, 2017. 978-9332584600
2. Kumar, A. Anand. Fundamentals of digital circuits.4/e PHI Learning, 2016. 978-8120352681
3. Stephan Brown & Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, 2/e, McGraw-Hill, 2007, ISBN-13: 978-0077211646
4. Taub, Herbert, and Donald L. Schilling. Digital integrated electronics. McGraw Hill, India, 2016 978-0070265080
5. Roth Jr, Charles H., Larry L. Kinney, and Eugene B. John. Fundamentals of logic design. Cengage Learning, 2020. 978-9353502645

23-200-0204B OBJECT ORIENTED PROGRAMMING IN C++

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the basic concepts of Object-Oriented Programming.
2. Describe the object-oriented paradigm with concepts of streams, classes, functions, data and objects.
3. Implement object-oriented programming constructs like encapsulation, inheritance and polymorphism.
4. Understand dynamic memory management techniques using pointers, constructors, destructors, etc.
5. Identify classes including data, methods and the relationship among the classes from a given problem statement and solve the problem using object-oriented constructs in C++.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Procedure oriented programming, Object oriented programming paradigm, Basic concepts of object-oriented programming, Benefits of OOP, Introduction to C++ programming, data types, variables, control statements (if, if else, switch), iteration (for, while, do...while). Console I/O operations - formatted and unformatted –managing output with manipulators. Functions in C++, call and return by reference, inline functions, default arguments, const arguments.

Module II

Classes and objects, specifying a class, defining member functions, Memory allocation for objects Static data members, Static member functions, Arrays of objects, const member functions Constructors and Destructors, Constructors: default, parameterised, with default arguments, copy constructor, destructors, Friend functions.
Introduction to pointers, new and delete operators, Pointers to objects, this pointer.

Module III

Inheritance: Defining derived classes, Single inheritance, Multilevel inheritance, multiple inheritance, Hierarchical inheritance, Hybrid inheritance, Virtual base classes, Abstract classes, Constructors in derived classes .
Polymorphism: Function overloading, operator overloading: overloading unary operators, overloading binary operators, overloading binary operators using friends, manipulation of strings using operators, Type conversions: basic to class, class to basic, class to class.

Module IV

Pointers to derived classes, virtual functions, pure virtual functions.
Working with files: classes for fstream operations, opening and closing of file, detecting end of file, file modes, file pointers and manipulators, sequential input and output operations, random access, Templates, Exception handling.

List of programs to practice:

1. Implementation of classes and objects.
2. Implementation of constructors and constructor overloading.
3. Implementation of methods and method overloading.
4. Implementation of different types of inheritance: Single Inheritance, Multilevel Inheritance, Hierarchical Inheritance, Multiple Inheritance, Hybrid Inheritance.
5. Implementation of polymorphism.
6. Implementation of File handling
7. Assignment: Design any real time application using object oriented concepts and develop the solution using the C++programming language. For this the students can form a project team with a maximum 4 members per team.The team can select a socially relevant problem from various domains such as health, safety, education, agriculture, legal etc. At the end of the semester, the team has to demonstrate their product and submit a report. The team will be assessed through rubrics.

References:

1. Balagurusamy, E. (2020). Object oriented programming with C++ (8th ed.).Tata McGraw Hill. New Delhi.
2. Lafore, R., & Lafore, R. (2002). Object oriented programming in C++ (4th ed.).Sams Pub.Indianapolis, Indiana.
3. Stroustrup, B. (2013). The C++ programming language (4th ed.). Reading, Mass.:Addison Wesley.
4. Kamthane, A. (2003). Object oriented programming with ANSI and Turbo C++.Pearson Education.Delhi, India.
5. Schildt, H. (2012). C++ the complete reference (5th ed.). Osborne McGraw Hill. Berkeley.

Pattern of Continuous Assessment

Test -I for the theory portions	:	15 marks
Test -II for the theory portions	:	15 marks
Assignment from the Theory	:	05 marks
Assignment from the Practice	:	10 marks
Attendance	:	05 marks
TOTAL	**:**	**50 marks**

The students are required to submit the practice record

23-200-0205B INTRODUCTION TO CYBER PHYSICAL SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the features & components of Cyber Physical Systems
2. Understand the elementary constructs of Arduino Software
3. Develop optimal programs & circuits for interfacing various sensors with Arduino
4. Apply Arduino IDE for developing suitable programs for interfacing sensors & actuators with Arduino & Node MCU

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to CPS, Key features of CPS-reactive computation, concurrency, Feedback Control of the Physical World, real time computation, safety critical applications, general structure of a CPS, Examples of CPS.
IoT- Characteristics of IoT, Enabling Technologies, Concept of Transducers/sensors-Primary & Secondary, active & passive, analog & digital, Concept about actuators-thermal, electric & mechanical, IoT stack, Levels of IoT.

Module II

Arduino Basics: Development Boards-Arduino Uno, Node MCU, Arduino IDE, General Program Structure, Basic data types, variables & constants, Operators, control statements, loops, functions, time functions, arrays.

Module III

Arduino-I/O functions, Arduino PWM, Arduino Communication, LED Interfacing-Sinking & Sourcing methods of LED Connection, LED blinking, fading, Analog read, LED bar graph display, Seven Segment LED Display, interfacing sensors with Arduino-humidity, temperature, water detector, PIR, ultrasonic sensor, LDR, Interfacing Push Button Switch-Pull Up & Pull-Down Connection.

Module IV

Arduino for motor control- Control of DC Motor, Servo motor & Stepper Motor.
Introduction to NodeMCU/ESP32, Overview of NodeMCU and its features, Programming NodeMCU via Arduino IDE, Interfacing LED, Gas Sensor, Introduction to Wi-Fi Connectivity with Node MCU.

References:

1. Rajeev Alur. Principles of Cyber-Physical Systems, MIT Press 2015
2. Edward Ashford Lee, Sanjit Arunkumar Seshia. Introduction to Embedded Systems-A Cyber-Physical Systems Approach -MIT Press 2017
3. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram.Internet of Things, WILEY 2020.
4. Srinivasa K.G, Siddesh G.M, Hanumantha Raju R.Internet of Things, CENGAGE, 2018.
5. Arduino-Tutorials point

23-200-0206B ENVIRONMENTAL AND LIFE SCIENCES

Course Outcomes:

On completion of this course the student will be able to:

1. Identify the global environmental issues
2. Examine the types of pollution in society along with their sources
3. Elucidate the basic biological concepts via relevant industrial applications and case studies.
4. Evaluate the principles of design and development, for exploring novel bioengineering projects.

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Environment, Ecosystems and Biodiversity: Definition, scope and importance of environment — need for public awareness — concept of an ecosystem — structure and function of an ecosystem — producers, consumers and decomposers — energy flow in the ecosystem — ecological succession — food chains, food webs and ecological pyramids — Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) — Introduction to biodiversity definition: genetic, species and ecosystem diversity —biogeographical classification of India — value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values — Biodiversity at global, national and local levels — India as a mega-diversity nation — hot-spots of biodiversity — threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts — endangered and endemic species of India — conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems — pond, river, hill slopes, etc.

Module II

Natural Resources: Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people — Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems — Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies — Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies — Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies — Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification — role of an individual in conservation of natural resources. The concept of sustainable development.

Module III

Biomolecules and their Applications (Qualitative): Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), Lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, Ligninolytic enzyme in bio-bleaching).

Nature-Bioinspired Materials and Mechanisms (Qualitative): Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).

Module IV

Human Organ Systems and Bio Designs (Qualitative): Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye). Heart as a pump system (architecture, electrical signaling – ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification systems (architecture, gas exchange

mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis).
Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods.

References:

1. Rajagopalan, R. Environmental Studies: From Crisis to Cure. Oxford University Press, New Delhi, (2015).
2. Erach Bharucha. Textbook of Environmental Studies and Ethics. Universities Press (India), Hyderabad, (2013).
3. Thyagarajan S., Velmurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jagannathan M.K. Biology for Engineers, Tata McGraw-Hill, New Delhi, (2012).
4. Arthur T. Johnson. Biology for Engineers, CRC Press, Taylor and Francis, (2019).
5. Sohini Singh and Tanu Allen. Biology for Engineers, Vayu Education of India, New Delhi, (2020).
6. Ibrahim Ozbolat. 3D Bioprinting: Fundamentals, Principles and Applications, Academic Press, (2016).

23-200-0207B DIGITAL ELECTRONICS LAB

Course Outcomes:

On completion of this course the student will be able to:

1. Understand working of gates, flip flops MUX, DEMUX, Shift registers ,counters etc.
2. Design digital circuits using appropriate ICs
3. Understand the timing diagrams
4. Develop teamwork skills

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Experiments:

Introduction to Data sheet of various digital ICs and their familiarization to be given before the hands on sessions

1. Half adder and full adder using standard logic gates / NAND gates.
2. Code converters - Binary to Gray and gray to Binary with mode control
3. Binary addition and subtraction (a) 1's complement (b) 2's complement(using7483)
4. BCD adder using7483.
5. Study of MUX, DEMUX & Decoder Circuits and ICs
6. Set up R-S JK & JK Master slave flip flops using NAND/NOR Gates
7. Asynchronous UP / DOWN counter using JK Flipflops
8. Design and realization of sequence generators.
9. Study of shift registers and Implementation of Johnson and Ring counters using them .
10. Study of counter ICs 7490, 7492, 7493.
11. Study of seven segment display and decoder driver (7447)- virtual lab

Hands-on wiring experiments may be supplemented by simulation using CAD tools / virtual labs etc.
At least 8 experiments must be mandatorily completed by every student and recorded.
Students are required to submit a simple project fully conceived, designed and developed by them at the end of the semester

References:

1. Herbert Taub, Donald Schilling, Digital Integrated Electronics, Tata Mc Graw Hill, 1/e, (2008), ISBN:9780070265080

23-200-0208B BASIC ELECTRONICS LAB

Course Outcomes:

On completion of this course the student will be able to:

1. To design and implement simple hardware circuits using electronic devices and digital ICs and to test the performance and its applications.
2. To use the basic logic gates and various reduction techniques of digital logic circuit in detail.
3. To design simple circuits and mini projects (groups) using sensors and electronic components

Course Articulation Matrix:

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

1-Slightly**; 2**-Moderately**; 3**-Substantially

Experiments:

1. Familiarization of electronic components and Electronic instruments – Power Supply, Function Generator, CRO, Multimeter.
2. VI characteristics of PN junction diode.
3. Clipping and clamping circuits
4. Design Rectifying circuits: (with and without filter)
    a. Half Wave Rectifier
    b. Full Wave Rectifier
5. Characterization of Passive Integrator and Differentiator Circuits.
6. Characterization of Transistor CE Configuration.
7. Design CE Amplifier for a particular Gain.
8. Electronic Systems Hardware Familiarization.
9. Introduction to PCB design.

References:

1. Jacob Milman & Christos C Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, McGraw Hill Education, 2 nd edition (2017).
2. David M. Buchla, Thomas L. Floyd, Electronics Pearson Education Limited, Year: 2014.

SEMESTER III

23-200-0301B DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES

Course Outcomes:

On completion of this course the student will be able to:

1. Apply complex analysis principles in engineering scenarios, understanding key concepts like analytic functions, Cauchy's theorem, and contour integration.
2. Employ linear algebra techniques, such as eigenvalues and linear transformations, to solve engineering problems and model real-world systems effectively.
3. Solve partial differential equations using various methods and apply the solutions to analyze phenomena in engineering, machine learning, and computational biology.
4. Utilize advanced differential equations, including wave and heat equations, Alembert's solution, and Fourier series, for modelling and analyzing complex engineering problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1		2							1	2	2	2	1
CO2	3	2	2		2							1	2	2	2	2
CO3	3	2	3		2							1	2	2	2	1
CO4	3	2	3	2	2								2	2	2	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Analytic Function: Analytic function, Cauchy-Riemann equation (Cartesian and polar), Harmonic function, Construction of analytic function given real or imaginary parts, Conformal mapping of standard elementary function and bilinear transformation. Applications of Analytic Functions in Signal Processing and Image Analysis.

Module II

Complex Analysis: Cauchy's integral theorem, Cauchy's integral formula and for derivatives, Taylor's and Laurent's expansion (without proof), Singularities, Residues, Cauchy's Residues theorem, Contour integration involving unit circle. Advanced Applications of Complex Analysis in Quantum Mechanics and Electrical Engineering.

Module III

Partial Differential Equations: Formation of partial differential equation eliminating arbitrary constants and function, Solution of the first-order equation, Four standard types, Lagrange's equation, Linear homogeneous partial differential equation with constant coefficient. Applications of Partial Differential Equations in Machine Learning and Computational Biology.

Module IV

Advanced Topics in Differential Equations: One-dimensional wave equation, Alembert's solution and one-dimensional heat flow equation, Solution by the method of separation of variables, Application of Fourier series solution, Solution of Laplace's equation over a rectangular region by the method of separation of variables, Recent Topics: Modern Applications of Wave and Heat Equations in Signal Processing and Materials Science.
The students should be introduced to Computer Algebra Systems (CAS) such as Matlab/Python (utilizing NumPy, SymPy, and SciPy) for both symbolic and numerical calculations. Homework and assignments should be given with the integration of CAS.

Case Studies for Assignment
Case Study 1: Complex Analysis and Partial Differential Equations with Python: Complex Numbers Arithmetic, Python Complex Numbers as 2D vectors, Solving first-order linear differential equations, Plotting Characteristic curves, Modeling Infectious disease
Case Study 2: Complex Analysis and Partial Differential Equations with MATLAB: Study of Complex functions and operations, Differential Equations – Ordinary and Partial, Solving Ordinary Differential Equations, Solving system of

Ordinary Differential Equations, Solving Partial Differential Equations

References :

1. Erwin Kreyszig, Advanced Engineering Mathematics, 11th Edition, John Wiley & Sons, (2022).
2. Grewal, B. S., Higher Engineering Mathematics, 45th Edition, Khanna Publishers, (2023).
3. Churchill, R.V. and Brown, J.W., Complex Variables and Applications, 10th Edition, McGraw Hill, (2021).
4. Stroud, K.A. and Booth, D.J., Advanced Engineering Mathematics, 6th Edition, Palgrave Macmillan, (2019).

23-204-0302 INTERNET PROGRAMMING

Course Outcomes:

On completion of this course the student will be able to:

1. Create semantically valid and standards-compliant web pages utilizing HTML5 and CSS3 for structure, styling and responsiveness.
2. Employ JavaScript, DOM and events to add interactivity and dynamic behavior in the front-end of web applications.
3. Develop back-end functionality using PHP and databases for server-side processing and data persistence.
4. Build scalable web APIs and full-stack web apps using asynchronous, event-driven Node.js and Express framework.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		3		3					1		2	3			1
CO2	3	2	2		3					1		2	3			2
CO3	3	2	3	1	3			1		1		2	2	3	1	3
CO4	3	3	3	1	3	2	1		1	1		2	3	2		3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Web: Internet, WWW, W3C, Web 2.0, web servers. HTML 5: Basic syntax, Standard document structure, Basic text markup, Images, Hypertext Links, Lists, Tables, Forms, internal linking. Cascading Style Sheets: Introduction to CSS3-Basic syntax and structure (colours, background, borders, margin, padding, font, display, position), Inline Styles, Embedded Style Sheets, Conflict Resolution, Linking External Style Sheets, CSS Box model, CSS responsiveness (media queries).

Module II

JavaScript: Overview of JavaScript, Screen output and keyboard input, Input with Dialogs, Memory concepts, operators, decision making, control statements, counter-controlled repetition, Arrays, Functions, objects, events. Document Object Model (DOM): DOM nodes and trees, DOM tree, DOM Collections, dynamic styles, Case study-Implementing Client-Side Interactivity with JavaScript.

Module III

PHP: PHP basics, string processing, regular expressions, Handling HTML form with PHP, connecting to the database, using cookies, dynamic content. Case study-Building a Responsive Website

Module IV

Node.js: Introduction to node, node.js, installation, Node.js Modules and NPM, Building a RESTful API: Understanding REST Concepts, Routing HTTP Requests, Connecting to Database, Modeling Data, CRUD Operations in database (Create, Read, Update, Delete), Introduction to Express.js, create a simple server using express. User authentication using express, connecting to the frontend.

Note: Implement case study as assignments.

References :

1. Deitel, P., & Deitel, H. (2022). Internet and World Wide Web: How to Program (8th ed.). Pearson Education.
2. Duckett, J. (2022). CSS and HTML for the web (2nd ed.). Wiley.
3. Nixon, R. (2022). PHP for Absolute Beginners (4th ed.). Apress.
4. Young, A., & Meck, B. (2022). Node.js in Action (3rd ed.). Manning Publications Co.
5. Wilson, J. (2017). Node.js 8 the Right Way (1st ed.). Pragmatic Bookshelf.
6. McDonald, R., & Powers, R. (2021). Learning PHP, MySQL & JavaScript: A Step-by-Step Guide to Creating Dynamic Websites (6th ed.). O'Reilly Media.
7. Craig, B. (2019). JavaScript: JavaScript Programming Made Easy for Beginners & Intermediates.

23-204-0303 DISCRETE COMPUTATIONAL STRUCTURES

Course Outcomes:

On completion of this course the student will be able to:

1. Apply mathematical logic and prove assertions using different proof techniques
2. Model computational problems using concepts of sets, relations and functions
3. Solve counting and enumeration problems using techniques like pigeonhole principle, recurrence relations
4. Represent discrete computational structures using graphs and trees, and analyze their properties
5. Apply algorithms like Fleury's over graphs to solve problems
6. Explain structural characteristics of algebraic structures like groups, rings, lattices

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2								1	3			
CO2	3	3	1	1								1	3			
CO3	3	3	1	2								1	2			
CO4	3	3	1	2								1	2			
CO5	2	1	1	2									1			
CO6	3	3	1	1								2	2			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Mathematical Logic: Propositions, Connectives, Equivalences of Proposition, Algebra of Propositions, Quantifiers, Proofs: Direct, Contraposition, Contradiction, Resolution, Mathematical Induction, Sets, Relations: properties, Representation, Composition of Relations, Equivalence Relation, Functions: Types, Composition of Functions.

Module II

Counting techniques: Counting Principle, Pigeonhole Principle, Recurrence relations, Order of Recurrence Relation, Linear Recurrence Relation with Constant Coefficients, Linear Homogeneous Recurrence Relation with Constant Coefficients.

Module III

Graphs: Definition and terminology, Representation of graphs, Multigraphs, Bipartite graphs, Planar graphs-Properties of planar graphs, connectivity, matching, graph coloring, Isomorphism of graphs, Euler and Hamiltonian paths and graphs, Fleury's Algorithm. Trees: Introduction to trees, Binary Tree, Spanning Trees.

Module IV

Algebraic Structures: Semigroups and Monoids, groups, subgroups, homomorphisms, Isomorphism, Rings, Field. Posets, Hasse Diagrams, Maximal-Minimal Element, Least upper bound (lub), Greatest Lower bound (glb), Lattice: Bounded Lattice, Sublattices, Isomorphic Lattices, Distributive Lattice.

References:

1. Rosen, K.H. (2021). Discrete Mathematics and Its Applications (8th ed.). McGraw Hill Higher Education.
2. Lehman, E., Leighton, F.T. & Meyer, A.R. (2017). Mathematics for Computer Science. CreateSpace Independent Publishing Platform.
3. Grimaldi, R.P. (2014). Discrete and Combinatorial Mathematics: An Applied Introduction. Pearson Education Limited.
4. Veerarajan, T. (2017) Discrete Mathematics with Graph Theory and Combinatorics. McGraw Hill Education.
5. Sastry, C. N. (2020). A Textbook on Discrete Mathematics. Wiley
6. S Epp. (2021). Discrete Mathematics with Applications (5th ed.). Cengage Learning India Private Limited

23-204-0304 DATABASE MANAGEMENT SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Explain database architecture and representation models.
2. Apply DDL and DML commands using SQL to retrieve data from the given table.
3. Apply normalization techniques to design a database for a given application.
4. Design data storage techniques for a given scenario.
5. Analyse concurrency control and transaction processing techniques.
6. Familiarize with different Database Management Systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1			2							2	2	3		
CO2	2	1										2	2	3		
CO3	2	2										2	2	2		
CO4	2				2							1	2	3		
CO5	2	2										1	2	2		
CO6	2				3	1						2	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction, Applications, Purpose of Database Systems, View of Data, Database Languages, Database Architecture, Database Users and Administrators. Database Design: The Entity Relationship Model, Constraints, Removing Redundant Attributes, Entity Sets, Entity Relationship Diagrams, Reduction to Relational Schemas, Extended E-R Features.

Module II

Relational Databases: Relational Model, Structure of Relational Databases, Database Schema, Keys, Schema Diagrams, Relational Query Languages, Relational Operations. SQL: Introduction, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Join Expressions, Relational Algebra. Advanced SQL: views, triggers.

Module III

Relational Database Design: Features of Good Relational Designs, Atomic Domains and First Normal Form, 2NF, 3NF, BCNF. Decomposition Using Functional Dependencies, Functional Dependency Theory. File Structure: File Organization, Organization of Records in Files.
Indexing and Hashing: Basic Concepts, Ordered Indices, Static Hashing, Dynamic Hashing.

Module IV

Transaction Management: Transaction concept, Simple Transaction Model, Transaction Atomicity and Durability, Serializability, Transaction Isolation and Atomicity, Transaction Isolation Levels. Concurrency Control: Lock Based Protocols, Deadlock Handling, Timestamp Based Protocols, Validation Based Protocols. Introduction to object-oriented databases.

References:

1. Silberschatz, A., Korth, H.F., & Sudarshan, S. (2019). Database System Concepts (7th ed.). Tata McGraw Hill.
2. Elmasri, R. & Navathe, S.B. (2017). Fundamentals of Database Systems (7th ed.). Addison Wesley.
3. Coronel, C., Morris, S., & Rob, P. (2022). Database Systems: Design, Implementation & Management (5th ed.). Thomson Course Technology.
4. Connolly, T. & Begg, C. (2022). Database Systems (3rd ed.). Pearson Education.
5. Dunham, M.H. (2003). Data Mining: Introductory and Advanced Topics. Pearson Education.
6. Prema, K., Reddy, A. G. S., & Reddy, K. (2020). Database Management System Concepts. Notion Press.
7. Date, C. J. (2019). Database design and relational theory: Normal Forms and All That Jazz(2nd ed). Apress.

23-204-0305 DATA STRUCTURES AND ALGORITHMS IN C++

Course Outcomes:

On completion of this course the student will be able to:

1. Analyse linear data structures such as arrays, linked lists, stacks and queues with their related operations
2. Implement various sorting and searching techniques.
3. Implement different types of trees, such as binary trees, AVL trees, etc and graphs and their operations
4. Identify suitable data structures and design techniques for developing algorithms to solve problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2								1	3	3		
CO2	3	3	2	1								1	3	3		
CO3	3	2	2	2								1	2	2		
CO4	3	2	2	2								1	3	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Data Structures, Types of Data Structures, Data Structure Operations, Abstract Data Type (ADT), Complexity of Algorithms. Linear Arrays: Representation, Inserting, deleting and traversing linear arrays. Searching: Linear search and Binary search in array and their complexity analysis. Sorting: Bubble sort, Selection sort, Insertion sort and their complexity analysis.

Module II

Linked List: Representation, Traversing, Searching, Insertion, Deletion. Two way lists: Representation, Traversing, Searching, Insertion, Deletion. Stack: Linked list representation of Stack, Applications of Stack: Polish Notation and Recursion. Queue: Linked list representation of queue, Priority Queue using linked list, Deque.

Module III

Trees, Binary trees, Linked list and Sequential representation of binary tree Traversing a binary tree: Preorder, Postorder and Inorder traversals. Introduction of Threaded binary tree, B Tree and Heap. Binary search tree, Inserting, deleting and searching a binary search tree AVL trees: Inserting, deleting and searching AVL tree.

Module IV

Graph, Graph terminology, Graph representation: Adjacency matrix, Adjacency list, Warshall's algorithm for the shortest path. Graph operations: Searching, Insertion, Deletion. Traversing a graph: DFS, BFS.

References:

1. Aho, A.V., Hopcroft, J.E., & Ullman, J.D. (2009). Data Structures and Algorithms. Dorling Kindersly.
2. Langsam, Y., Augenstein, M., & Tenenbaum, A. M. (2015). Data Structures Using C and C++. (2nd ed). Pearson Education
3. Horowitz, E., Sahni, S., & Mehta, D.P. (2008). Fundamentals of Data Structures. Silicon Press.
4. Samantha. D., (2009). Classic Data Structures. Prentice Hall India Learning Private Limited.
5. Drozdek, A. (2012). Data Structures and Algorithms in C++. Course Technology Ptr.
6. Venkatesan, R., & Rose, S. L. (2019). Data Structures (2nd ed.). Wiley.
7. Karuppiah. (2020). Fundamentals of Data Structures and Algorithms. Lambert Academic Publishing

23-204-0306 COMPUTER ORGANIZATION AND ARCHITECTURE

Course Outcomes:

On completion of this course the student will be able to:

1. Understand computer architecture principles and operational concepts, including instruction sequencing, addressing modes, and arithmetic operations in binary systems.
2. Analyze and differentiate between hardwired and microprogrammed control units, implementing control signals and micro instructions effectively in CPU design.
3. Evaluate memory organization strategies, including cache memories, virtual memory, and addressing translations, optimizing performance considerations in memory access.
4. Design and implement efficient input/output systems, including interrupt handling, DMA, and standard I/O interfaces, while assessing the impact of pipelining and multicore architectures on system performance.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1						1	2	2	1	
CO2	2	3	1	2	2	1						1	2	2		
CO3	2	2	3	2	2	1						1	2	2		
CO4	2	2	2	3	2	1						1	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Basic structure of computers: Functional units, Basic operational concepts, Bus structures Instructions & instruction sequencing. Hardware and software, Addressing modes, Assembly language, Stacks & Subroutines. Computer arithmetic, Two's complement Number representation and arithmetic. Multiplication: Booth's algorithm, Fast multiplication, Integer division, Floating point numbers and operations.

Module II

Processing Unit Fundamental concepts –Execution of a complete instruction, Hardwired control unit, Microprogrammed control, Control signals, Micro instructions, Microprogram sequencing Emulation.

Module III

Memory organization Semiconductor RAM memories, internal organization of memory chips Static and Dynamic memories, cache memories, mapping functions, replacement algorithms, virtual memory, address translations – performance considerations. Interleaving, Secondary storage.

Module IV

Input output organizations, Interrupts Enabling & Disabling interrupts, handling multiple devices, device identification, vectored interrupts, interrupt nesting Simultaneous requests DMA, Buses, I/O interface circuits –Standard I/O interfaces. Basic Concepts of Pipelining: Basic Concepts, Role of Cache memory, Pipeline performance, Data Hazards, Instruction Hazards, Multicore: Basic Concept, Interconnection: NoC

References :

1. Hamacher, Vranesic, & Zaky. (2017). Computer Organization (5th ed.). McGraw Hill Education.
2. Patterson, D.A. & Hennessy, J.L. (2021). Computer Organization and Design: The Hardware/Software Interface (6th ed.). Elsevier
3. Stallings, W. (2022). Computer Organization and Architecture: Designing for Performance (11th ed.). Pearson Education
4. Hayes, J.P. (2017). Computer Architecture and Organization. (3rd ed). McGraw Hill.
5. Deebalakshmi, Umanesan, & Ravindran. (2022). Computer Organization and Architecture. Notion Press .

23-204-0307 HARDWARE DESIGN & CPS LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Familiarize with troubleshooting, maintenance and Assembling a PC.
2. Demonstrate proficiency in writing and testing assembly language programs for 8086 microprocessors, utilizing data transfer, arithmetic, logical, and program control instructions to solve basic computational problems.
3. Acquire practical skills in interfacing sensors, actuators, and displays with Arduino boards, implementing programming constructs to build applications such as temperature monitoring, motion detection, and environmental sensing.
4. Develop competence in designing and simulating combinational and sequential logic circuits using FPGA development tools and hardware, culminating in the creation of digital systems including calculators, digital clocks, and gaming applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		1									1	2	3		
CO2	2	1	1		2							2	2	1		
CO3	1	3	1	2	3								3			
CO4	1	2	2	1	1				1			2	1			

1-Slightly**; 2**-Moderately**; 3**-Substantially

PC HARDWARE:

Computer peripherals - Keyboard, mouse, monitor, printers
Motherboard components - CPU, chipset, BIOS, memory, storage, ports
Power supply unit and cabling
Assembling and troubleshooting a PC

8086 MICROPROCESSOR PROGRAMMING

Familiarization 8086 kit, addressing modes and instruction set, Assembly language programming
Write and test simple assembly language programs using data transfer and arithmetic instructions

8086 addressing modes

Write programs using different addressing modes like immediate, direct, register, memory-based
Learn assembler directives for allocation of memory

Logical instructions

Write programs using logical instructions like AND, OR, XOR, NOT
Use logical instructions in a program for specific applications

Program control instructions

Use conditional and unconditional jump instructions
Write and execute program loops using looping instructions
(Eg.: Here are 4 sample lab experiments for an 8086 basic programming lab cycle:

- Write an 8086-assembly language program to add two 8-bit numbers and store the result in a register. Use data transfer and arithmetic instructions.
- Write a program to find the largest number in an array of 8-bit numbers stored in memory. Use conditional jump instructions and loops.
- Write a program to convert a hexadecimal number to its equivalent BCD (Binary Coded Decimal) number. Use logical and data transfer instructions.
- Write a program with procedures to calculate the factorial of a number entered by the user. Pass parameters to procedures properly)

ARDUINO PROGRAMMING

Arduino boards and IDE, Digital and analog I/O, Programming constructs, Interfacing sensors, motors, LCD

- Communication protocols (Eg.: Interface a DHT11 temperature and humidity sensor with Arduino. Display readings on an LCD screen.
- Read data from a PIR motion sensor. Turn on an LED and buzzer when motion is detected.
- Interface a soil moisture sensor and display the moisture levels on the serial monitor.
- Connect an ultrasonic sensor and use it to calculate distance to an object. Display the distance on an LCD screen.

FPGA PROGRAMMING

Introduction to FPGA board: Learn how to setup the FPGA board and development tools. Get familiar with the board interfaces like switches, buttons, LEDs, 7-segment display
Combinational logic circuits: Design and implement basic combinational logic circuits using HDL such as VHDL or Verilog

- Implementing basic logic gates (AND, OR, NOT, XOR, etc.).
- Designing and simulating sequential circuits like counters, shift registers, etc.
- Creating a digital clock.
- Building a simple calculator or arithmetic logic unit (ALU).
- Developing simple embedded applications like digital thermometers, traffic light controllers, etc.
- Creating simple gaming applications.
- Image and Video Processing: Implementing edge detection, binarization, color detection, object detection etc.

References:

1. Gilster. (2001). PC Hardware: A Beginner's Guide. Tata McGraw-Hill Education.
2. Smith, A. (2011). Introduction to Arduino. CreateSpace Independent Publishing
3. Hall, D. V. (2017). Microprocessors And Interfacing. (3rd ed) McGraw Hill Education
4. Ayala, K. (2021). The 8051 Microcontroller. Cengage.
5. M.Geddes (2017). Arduino Project Handbook. No Starch Press
6. Mazidi, M. A., & Mazidi, J. G. (2020). The 8051 Microcontroller and Embedded Systems. VISIONIAS
7. Russell Merrick (2023). Getting Started with FPGAs: Digital Circuit Design, Verilog, and VHDL for Beginners. No Starch Press

23-204 0308 DATA STRUCTURES IN C++ LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Use linear and nonlinear data structures for a given application.
2. Perform data manipulation in a given application using searching and sorting techniques.
3. Develop application to solve the real-world problem by selecting the suitable data structure.
4. Improve communication and team building skills.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1					1			1	3	3		
CO2	3	3	2	1					1			1	3	3		
CO3	3	2	2	1					1			1	3	2		
CO4	3	2	2	2					1			1	3	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Lab Cycle

- Implementation of classes and objects
- Implementation of inheritance
- Implementation of polymorphism.
- Implementation of operations of an array: insertion, deletion, traversing and displaying.
- Implementation of Linear Search and Binary search on an array.
- Implementation of sorting algorithms: bubble sort, selection sort, insertion sort.
- Implementation of Linear Linked List and its operations.
- Implementation of Doubly Linked List and its operations.
- Implementation of Circular List and its operations
- Implementation of Stack and Queue using Linked List.
- Implementation of Binary Search Tree and its operations.
- Implementation of Binary Search Tree and its traversals: preorder, in order, post order.
- Implementation of Stack and Queue using Array.
- Implementation of Circular Queue and its operations.

Assignment:

Design of any real time application:

Instructions:

Students can form a project team with around 5 members per team.

The team can select the problem(s) from societal, health, safety and legal domains. Using C programming language for application development, the team has to identify and use a suitable data structure to implement the project.

At the end of the semester, the team has to present their project, submit a hand written report in their lab record. The team is assessed through rubrics.

References :

1. Aho, A. V., Hopcroft, J. E., & Ullman, J. D. (2009). Data Structures and algorithms. Delhi: Dorling Kindersly.
2. Langsam, Y., Augenstein, M., & Tenenbaum, A. M. (2000). Data structures using C and C++. New Delhi: Prentice Hall of India.
3. Horowitz, E., Sahni, S., & Mehta, D. P. (2008). Fundamentals of data structures. Summit, NJ: Silicon Press.
4. Samantha D(2009). Classic Data Structures : Prentice Hall India Learning Private Limited
5. Venkatesan, R., & Rose, S. L. (2019). Data Structures (2nd ed.). Wiley.
6. Karuppiah. (2020). Fundamentals of Data Structures and Algorithms. Lambert Academic Publishing.
7. Balagurusamy, E. (2020). Object oriented programming with C++ (8th ed.).Tata McGraw Hill. New Delhi.
8. Lafore, R., & Lafore, R. (2002). Object oriented programming in C++ (4th ed.).Sams Pub.Indianapolis, Indiana.

23-200-0309 INTERNSHIP-I

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject of area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organization of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial/incubation/ innovation /entrepreneurship/lab environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1			2	1		2	2	2	1	2
CO2	2	3	1	2	2	1			2	2	1	1	2	2		1
CO3	2	2	3	2	2	1			2	2	1	1	2	2		2
CO4	2	2	2	3	2	1			2	2	1	1	2	2		1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Internship Guidelines

During the summer vacations, after the 2nd Semester, students are required to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the University; contribution at incubation/ innovation /entrepreneurship cell of the University; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc. A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review. Training Certificate from the Inter/Intra Institutional Activities from the concerned department/lab as mentioned above for the prescribed period shall be submitted at the end of the internship which can be considered as evidence for the the Internship-1.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of the internship	10
5.	Internship Report – Presentation style and content	10
Total		**50** Marks

SEMESTER IV

23-200-0401B NUMERICAL AND STATISTICAL TECHNIQUES

Course Outcomes:

On completion of this course the student will be able to:

1. Comprehend foundational concepts in numerical analysis, statistical methods, and machine learning, including understanding the importance of numerical methods and statistical techniques in problem-solving.
2. Apply various numerical methods and statistical tests to solve algebraic and transcendental equations, analyze data, and draw inferences about populations and samples.
3. Evaluate and compare the efficiency of numerical techniques in solving engineering problems, demonstrating analytical skills in differentiation, integration, and solving ordinary differential equations.
4. Apply advanced statistical and machine learning techniques using Pandas for data exploration and processing, showcasing proficiency in descriptive statistics, regression analysis, and the implementation of basic machine learning models

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1						1	2	2	1	
CO2	2	3	1	2	2	1						1	2	2		
CO3	2	2	3	2	2	1						1	2	2		
CO4	2	2	2	3	2	1						1	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Numerical Analysis: Understanding Numerical Methods, Importance in Problem Solving, Error Analysis and Approximations. Numerical solution of algebraic and transcendental equations: Bisection, Newton-Raphson, Secant and Successive Iteration Method. System of Equations: Gauss-Seidel Iteration (Convergence without proof). Interpolation and Approximation: Polynomial, Lagrange, Newton's Forward/Backward/Divided-Difference, and Least Squares. Taylor's Theorem: Taylor series expansion, Taylor Polynomial and Maclaurin Series.

Module II

Numerical Differentiation at Tabulated Points: Forward, Backward, Central Differences. Numerical Integration: Trapezoidal, Simpson's, Gaussian Quadrature. Ordinary Differential Equations (ODEs): Initial Value Problems- Euler's Method, Runge-Kutta (2nd & 4th Order), Boundary Value Problems-Finite Difference Method (First & Second Order BVPs).

Module III

Statistical Concepts and Tests: Random Variables, Expectation, Mean, Variance. Probability Distributions: Binomial, Poisson, Normal. Statistical Inference: Population, Sample, Sampling Distributions (Mean & Variance). Hypothesis Testing: Level of Significance, Z-Test, Chi-Square Tests (Variance & Goodness of Fit), F-Test.

Module IV

Descriptive Statistics and Regression Analysis. Overview of Descriptive Statistics. Regression Analysis of Numerical Data. Regression Analysis of Categorical Data. Visualization of Data Trends. Basic Concepts of Machine Learning: Introduction to Supervised Learning, Overview of Classification and Regression, Introduction to Unsupervised Learning: Clustering. Utilize Pandas for data exploration and processing.
The students should be introduced to Computer Algebra Systems (CAS) such as Matlab/Python (utilizing NumPy, SymPy, and SciPy) for both symbolic and numerical calculations. Homework and assignments should be given with the integration of CAS.

Case studies for Assignment
Case Study 1: Numerical and Statistical Methods with Python: Finding Roots of functions, Numerical Differentiation, Numerical Integration, Probability Distributions, Regression Analysis
Case Study 2: Numerical and Statistical Methods with MATLAB: Determination of Roots of a Polynomial,

Determination of Polynomial using Least Square Method, Finding Taylor and Maclaurin Series Expansions, Solution of Differential Equation using Euler Method, Solution of Differential Equation using 4th order Runge-Kutta Method

References:

1. Kreyszig, E. (2015). Advanced Engineering Mathematics (10th ed.). John Wiley & Sons.
2. Grewal, B. S. (2018). Higher Engineering Mathematics (44th ed.). Khanna Publishers.
3. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2019). Numerical Methods: For Scientific and Engineering Computation (7th ed.). New Age International Private Limited.
4. Devore, J. L. (2020). Probability and Statistics: For Engineering and the Sciences (9th ed.). Cengage India Private Limited.
5. McKinney, W. (2022). Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter (3rd ed.). O'Reilly Media.
6. Muller, A. C., & Guido, S. (2018). Introduction to Machine Learning with Python: A Guide for Data Scientists. O'Reilly Media.

23-204-0402 DATA COMMUNICATION

Course Outcomes:

On completion of this course the student will be able to:

1. Demonstrate an understanding of the functionalities and implementations of network protocols.
2. Evaluate the functionalities and protocols within the ISO/OSI Network model..
3. Evaluate specific application requirements and choose suitable transport/application layer protocols accordingly.
4. Recommend congestion control and avoidance techniques tailored to the characteristics of the traffic scenario.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2		3								3	2		
CO2	3	3	3	1	3		3						2	2		
CO3	3		3		3								2	2		
CO4	3	3	3	1	3		3						2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction –Data Communications, Networks, The Internet, Protocols and Standards. Network Models, ISO/OSI Reference Model, TCP/IP Reference Model.

Physical Layer and Media: Data and Signals: Analog and Digital, Transmission Impairments, Data Rate Limits, Performance, Digital to Digital Conversion, Analog to Digital Conversion, Digital to Analog Conversion, Analog to Analog Conversion.

Module II

Data Link Layer: Error Detection And Correction Types of Errors, Redundancy, Detection Vs Correction, Forward Error Correction Vs Retransmission, Block coding, Cyclic Codes, CRC, Polynomials, Checksum.

Data Link Control: Framing, Flow and Error Control, Protocols, Noiseless and Noisy channel, Point to Point Protocols. Wired LANs Ethernet, Wireless LANs IEEE 802.11, Bluetooth.

Module III

Introduction to Network Layer Logical Addressing, Internet Protocol, IPV4, IPV6, Address Mapping, Routing Algorithms –Distance Vector Routing, Link State Routing. Unicast Routing Protocols.

Module IV

Transport Layer: Process to Process Delivery– Port Addressing, TCP & UDP Segment Format, TCP Connection, Congestion Control and Quality of service.

Application Layer Services: Domain Name System, Electronic Mail, File transfer, WWW & HTTP, Network Management: SNMP.

References:

1. Forouzan, B. S. (2022). Data Communications and Networking: with TCP/IP Protocol Suite (6th ed.). McGraw-Hill.
2. Kurose, J. F., & Ross, K. W. (2022). Computer networking: A Top-down Approach (8th ed.). Pearson Education.
3. Tanenbaum, A. S., Feamster, N., & Wetherall, D. J. (2022). Computer Networks (6th ed.). Pearson Education India.
4. Comer, D. E. (2018). Computer Networks and Internets (6th ed.). Pearson Education.
5. Stallings, W. (2014). Data and Computer Communications (10th ed.). Pearson Education Limited.
6. Peterson, L. L., & Davie, B. (2020). Computer networks: A Systems Approach (6th ed.). Morgan Kaufmann Publishers.

23-204-0403 OPERATING SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Explore the functions of process, memory, file system, and device management within an operating system
2. Compare and evaluate different CPU scheduling algorithms.
3. Design and implement memory management schemes, covering contiguous allocation, paging, and segmentation.
4. Demonstrate the use of file systems, as well as identify and handle potential issues like deadlocks situations

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2										3	3		
CO2	3	2	3										3	3		
CO3	**3**	3	3	2	1								3	3		
CO4	**3**	2	3	2	1								2	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Operating Systems: Operating system concepts, System calls, Operating System Structure. Processes: Process Concept. Process Scheduling, CPU Scheduling: Scheduling Criteria, Scheduling Algorithms: First come First Served, Shortest Job First, Priority scheduling, Round Robin Scheduling, Multiple queues scheduling, Guaranteed scheduling, Two level scheduling.

Module II

Memory management. Multiprogramming and memory usage, Swapping, multiprogramming with fixed and variable partitions, Memory management with bitmaps, linked lists, Buddy system, Allocation of swap space. Virtual memory: paging and page tables, Associative memory, Inverted page tables; Page replacement algorithms, Segmentation.

Module III

Inter process Communication; Process Synchronization: Race Conditions, Critical Sections, Mutual Exclusion, Busy Waiting, Sleep and Wakeup Semaphores.
Deadlock: Conditions for deadlock, Deadlock Characterization, Methods for handling deadlock, Deadlock prevention, Deadlock avoidance: resource trajectories, safe and unsafe state, Banker's algorithm. Deadlock detection and recovery, Starvation, Priority inversion, livelock.

Module IV

File systems and Input/output: Files, Directories, File system implementation, Directory Implementation, Security and Protection mechanisms.
Principles of I/O hardware, I/O devices, Device controllers, DMA. Principles of I/O software, Interrupt handlers, Device drivers, Disk scheduling, Clocks and terminals. I/O Buffering, RAID.
Case Study: UNIX / LINUX operating system.

References:

1. Silberschatz, A., Galvin, P. B., & Gagne, G. (2021). Operating system concepts (10th ed.). John Wiley & Sons.
2. Tanenbaum, A. S., & Bos, H. (2022). Modern operating systems (5th ed.). Pearson
3. Stallings, W. (2018). Operating systems: Internals and Design Principles (9th ed.). Pearson.
4. Dhamdhere, D. M. (2017). Operating Systems: A Concept-Based Approach. (3rd ed.). McGraw Hill Education.
5. Davis, W. S., & Rajkumar, T. M. (2005). Operating systems: A Systematic View (6th ed.). Addison-Wesley Longman

23-204-0404 SOFTWARE ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Apply engineering principles, understand requirements, choose lifecycle models, apply design concepts and UML.
2. Demonstrate proficiency in project management - planning, estimation, cost/schedule management, risk identification/mitigation.
3. Develop comprehensive test plans, various testing techniques/methodologies, apply to projects.
4. Gain experience through projects - requirements engineering, design, project management, testing, software engineering practices.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	1					**2**		2	1	1		**3**
CO2	3	2	3	2	2	1				1	**2**	1	2	1	1	**3**
CO3	2	2	2			3				2		1	1	1	1	**2**
CO4	2	2	3	3	3	1					**2**	1	2	2	1	**1**

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Software Engineering: Definition, Evolution of Software Engineering, Software components, Software Characteristics, Software Engineering Process, Agile process, Extreme programming.
Software Life Cycle models: Water fall model, Prototyping, Incremental, Spiral model, pros and cons of each model. Requirement Engineering Process: Feasibility study, Requirement Elicitation, Analysis, Documentation, Functional and non-functional requirements, SRS Document, IEEE format of SRS.

Module II

Software Design: Design concepts, Function oriented design, Structured analysis, DFD, Structured design, Cohesion and Coupling, Software architecture, Structure Chart, Case study. Introduction to Object Oriented Design, User Interface Design.

Module III

Software Quality: Evolution of software quality, Quality factors, SQA activities, Quality Standards, ISO 9000 and CMM. Software Testing: Concepts and Objectives of testing, Testing activities, Functional (Black box) and Structural (White box), Unit testing, Integration testing, System testing, Acceptance Testing, Performance testing, Regression Testing. Software configuration management.

Module IV

Software Project Management: Planning, Organizing, Staffing, Directing and Controlling. Software Project Estimation: LOC and FP Based Estimation, COCOMO. Software Project Scheduling: Work Breakdown Structures, Activity Network, Gantt chart, Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM).

References:

1. Pressman, R. S., & Maxim, B. R. (2023). Software Engineering: A Practitioner's Approach (9th ed.). McGraw Hill.
2. Mall, R. (2018). Fundamentals of Software Engineering (5th ed.). PHI.
3. Jalote, P. (2008). A concise introduction to software engineering. Springer.
4. Limaye, M. (2011). Software Quality Assurance. Tata McGraw Hill Education.
5. Limaye, M. G. (2009). Software testing: Principles, Techniques and Tools. Tata McGraw-Hill Education.
6. Aggarwal, K. K., & Singh, Y. (2021). Software Engineering (4th ed.). New Age International Publishers.

23-204-0405 FORMAL LANGUAGES AND AUTOMATA THEORY

Course Outcomes:

On completion of this course the student will be able to:

1. Develop formal notations for strings, languages, and machines, designing finite automata to accept strings of a language.
2. Prove language regularity, apply closure properties, and design context-free grammars to generate strings from context-free languages, converting them into normal forms.
3. Establish and Analyse equivalence between classes of languages (regular, context-free, context-sensitive, recursively enumerable) and their corresponding machine models (FA, PDA, LBA, TM)
4. Distinguish between computability and non-computability, as well as decidability and undecidability, in the context of formal languages and automata theory.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	1								2	2		
CO2	3	2	3	2	2								2	1		
CO3	2	2	2										1	1		
CO4	2	2	3	3	2							1	2	2		1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Finite Automata (FA) and Regular Expression: NFA, DFA, Equivalence of NFA and DFA, Equivalence of NFA and NFA with epsilon moves, regular expression, Equivalence of regular expression and finite automata, Finite automata with output, Equivalence of finite automata with output (Moore and Mealy Machines), Equivalence of Moore and Mealy machines, Applications of Finite automata.

Properties of Regular sets: Pumping Lemma, closure properties, Myhill-Nerode theorem.

Module II

Context Free Grammars and languages: Definitions, Derivations parse Trees, Ambiguity, Simplification of CFG, Normal forms of CFG, Chomsky Normal form, Greibach Normal Form. Push Down Automata (PDA): Definition of PDA & DPDA, Languages of PDA, Equivalence of PDA and CFL, Applications of CFG, pumping lemma for CFL, Closure Properties, and Decision algorithms. Case Study for Assignment: Regular Expressions in Text Processing

Module III

Turing machine: TM model, Computational Languages and Functions, Techniques for construction of TM, NDTM.

Undecidability: Decidable & undecidable problems, properties of recursive and recursively enumerable languages, Universal TM and an undecidable problem.

Module IV

Chomsky Hierarchy: Regular Grammars, equivalence of regular grammar and FA, Unrestricted Grammars, equivalence of unrestricted grammar and TM, Context Sensitive Languages (CSL) and Linear Bounded Automaton (LBA), Equivalence of LBA and CSL, Relation between languages.

Case Study for assignment: Automata are applied to network protocols (Protocol Specification, Modeling and Verification, Routing, Switching)

References:

1. Hopcroft, J. E., Motwani, R., & Ullman, J. D. (2008). Introduction to Automata Theory, Languages, and Computation (3rd ed.). Pearson Education India.
2. Lewis, H. R., & Papadimitriou, C. H. (2015). Elements of the theory of computation (2nd ed.). Pearson.
3. Kozen, D. C. (2007). Automata and computability. Springer Science & Business Media.
4. Sipser, M. (2012). Introduction to the Theory of Computation (3rd ed.). Cengage Learning.
5. Martin, J. C. (2010). Introduction to languages and the theory of computation (4th ed.). McGraw-Hill Education.
6. Linz, P., & Rodger, S. H. (2022). An Introduction to Formal Languages and Automata (7th ed.). Jones & Bartlett Learning.

23-204 -0406 DESIGN AND ANALYSIS OF ALGORITHMS

Course Outcomes:

On completion of this course the student will be able to:

1. Analyse the time and space complexity of an algorithm using different asymptotic notations.
2. Implement algorithms for various computing problems using divide and conquer and greedy approaches.
3. Apply Dynamic Programming, Backtracking and Branch and Bound concepts to solve various problems.
4. Examine the type of problem (NP hard, NP complete) for the given scenario

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1								1	3	3		
CO2	3	3	2	1								1	3	3		
CO3	3	2	2	1								1	3	2		
CO4	3	2	2	2								1	3	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Analyzing Algorithms and problems. Classifying functions by their asymptotic growth rate. Recursive procedures. Recurrence equations, Substitution Method, Changing variables, Recursion Tree, Master Theorem. Design Techniques: Divide and Conquer, Dynamic Programming, Greedy, Backtracking.

Module II

Divide and conquer: Analysis of binary search, quick sort, merge sort
Greedy method: - job sequencing with deadlines, Fractional knapsack problem, Single source shortest path problem.

Module III

Dynamic programming: 0/1 knapsack problem, All Pairs Shortest Path problem, Travelling sales person problem
Backtracking: Sum of subsets problem, Graph colouring and Hamiltonian cycles.

Module IV

Branch and bound: Travelling sales person problem, 0/1 knapsack problem. Complexity Theory, Introduction. P and NP. NP Complete problems

References:

1. Horowitz, E., Sahni, S., & Rajasekaran, S. (2008). Fundamentals of computer Algorithms. Universities Press.
2. Lee, R. C. T., Tseng, S. S., & Chang, R. C. (2012). Introduction to the Design and Analysis of Algorithms: A Strategic Approach. McGraw Hill Education.
3. Weiss, M. A. (2014). Data Structures and algorithm analysis in C++ (4th ed.). Pearson.
4. Baase, S. (2009). Computer Algorithms: Introduction to Design and Analysis (3rd ed.). Pearson Education India.
5. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). Introduction to Algorithms (4th ed.). MIT Press.

23-204-0407 UNIVERSAL HUMAN VALUES

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize needs, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity.
2. Understand human being as the co-existence of two realities, self and body and harmony in the individual level.
3. Verify the possibility of ensuring within the naturally acceptable feelings and express those to the others with an expectation of mutual happiness and mutual prosperity.
4. Identify the harmony in society, nature and existence and ensuring them through the effort to fulfil the human goal.
5. Apply the understanding of ethical human conduct to formulate strategies for ethical life and profession.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1			1			2	2	1	2	2	2	2				
CO2			1			2	3	1	3	1	2	2				
CO3			1			2	2	3	3	3	2	2				
CO4			1			3	3	3	3	3	3	3				

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education.

Purpose and motivation for the course, recapitulation from Universal Human Values-I.

Self-Exploration–what is it? – Its content and process; 'Natural Acceptance' and experiential Validation- as the process for self-exploration.

Continuous Happiness and Prosperity – A look at basic Human Aspirations.

Right understanding, Relationship and Physical Facility – the basic requirements for the fulfilment of aspirations of every human being with their priority.

Understanding Happiness and Prosperity rightly- A critical appraisal of the current Scenario.

Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human beings as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than arbitrariness in choice based on liking-disliking.

Module II

Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human beings as a co-existence of the sentient 'I' and the material 'Body'.

Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.

Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).

Understanding the characteristics and activities of 'I' and harmony in 'I'.

Understanding the harmony of I with the Body: Self-regulation (Sanyam) and Health; correct appraisal of Physical needs, the meaning of Prosperity in detail.

Programs to ensure Self-regulation (Sanyam) and Health.

Include practice sessions to discuss the role others have played in making material goods available to one self, identifying from own life. Differentiate between prosperity and accumulation. Discuss a program for ensuring health vs dealing with a disease.

Module III

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

Understanding values in a human-human relationship; the meaning of Justice (nine universal values in relationships) and the program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.

Understanding the meaning of Trust; Difference between intention and competence.

Understanding the meaning of Respect, the difference between respect and differentiation; the other salient values in a relationship.

Understanding the harmony in the society (society being an extension of the family): Resolution, Prosperity, fearlessness

(trust) and co-existence as comprehensive Human Goals.
Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real-life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module IV

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence
Understanding the Harmony in Nature.
Interconnectedness and mutual fulfilment among the four orders of nature – recyclability and self-regulation in nature.
Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
Holistic perception of harmony at all levels of existence.
Include practice sessions to discuss human beings as the cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Implications of the above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values, Definitiveness of Ethical Human Conduct.
Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
Competence in professional ethics: a. Ability to utilize professional competence for augmenting universal human order, b. Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for the above production systems.
Case studies of typical holistic technologies, management models and production systems.
Strategy for the transition from the present state to Universal Human Order: a. At the level of the individual: as socially and ecologically responsible engineers, technologists and managers, b. At the level of society: as mutually enriching institutions and organizations.
Sum up.
Include practice exercises and case studies to discuss the conduct as an engineer or scientist etc.

References:

1. Gaur, R. R., Asthana, R., & Bageria, G. P. (2022). Human values and professional ethics (3rd rev. ed.). Excel Books..
2. Nagaraj, A. (2022). Jeevan Vidya: Ek Parichaya (3rd ed.). Jeevan Vidya Prakashan.
3. Tripathi, A. N. (2022). Human values (5th ed.). New Age Intl. Publishers.

23-204-0408 OPERATING SYSTEMS LAB

Course Outcomes:

On completion of this course the student will be able to:

1. Apply basic knowledge in LINUX shell scripts and execute various shell programs.
2. Demonstrate different Inter process communication techniques.
3. Analyse and evaluate different process scheduling techniques.
4. Evaluate various memory management schemes.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	3				1	2		1	3	3		
CO2	2	2	3	2	3				1	2		1	3	3		
CO3	2	2	3	2	3				1	2		1	3	3		
CO4	2	2	3	2	3				1	2		1	3	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Experiments

1. Linux Commands for file management, extract, sort and filtering data, basic terminal navigation
2. Shell Scripting for System Information, simple arithmetic operations, File Handling and String Manipulation.
3. System Calls for parallel processing: fork, join, exec, getpid, pipe communication.
4. IPC using shared memory, message queue, semaphores using p_threads.
5. Process Scheduling: FCFS, SJF, Round Robin, Priority scheduling
6. Main Memory Management Schemes: MFT, MVT
7. Virtual Memory : Page Replacement Algorithms – FIFO, Optimal, LRU
8. Deadlock detection and avoidance algorithms – Banker's algorithm

References:

1. Silberschatz, A., & Galvin, P. (2018). Operating system concepts (10th ed.). John Wiley and Sons.
2. Tanenbaum, A. S., & Bos, H. (2022). Modern operating systems (5th ed.). Pearson
3. Stallings, W. (2018). Operating systems: Internals and Design Principles (9th ed.). Pearson.

23-204-0409 MINI PROJECT – DBMS BASED

Course Outcomes:

On completion of this course the student will be able to:

1. Design and develop RDBMS prototype with schema/table management, data manipulation, querying, and basic web/desktop application integration.
2. Develop NoSQL database prototype for dynamic/unstructured data, schema-less design, document storage, flexible querying, and web/desktop CRUD application.
3. Differentiate NoSQL's schema less design, horizontal scaling, varied data models from RDBMS's structured schema, vertical scaling, relational model; identify suitable use cases.
4. Present project design, difficulties, solutions, tools, advanced techniques, DBMS demonstration, and web application.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3							1	2		2	3	3		
CO2	2	3	3		3				1	2		2	3	3		
CO3	2	3	2		3				1	2		2	3	2		
CO4	2	3	3		3				1	2		1	3	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A

Students will complete the following experiments in lab to get an introduction to SQL queries and establishing database connectivity with the front end and back end. (2 lab sessions)

- Program to demonstrate various SQL commands.
- DDL commands including Create database, Drop database
- DML commands including Create Table, Insert, Delete, Update, Select, Join

Project Description

It is required to design and develop a RDBMS prototype that implements the concepts and basic functionalities of a typical RDBMS. The RDBMS will have capabilities of creating schemas and tables, inserting and manipulating data, and conducting queries. A basic web application/desktop application will be created with your DBMS as the back end.

Part B

A NoSQL database prototype is being developed to handle dynamic and unstructured data, emphasizing schema-less design, document-oriented storage, and flexible querying. To showcase its capabilities, a basic web/desktop application will be created to interact seamlessly with the NoSQL backend, enabling CRUD operations. This integration demonstrates the practical application of NoSQL databases in modern, scalable systems.

Presentation

You will be required to present your project. Your presentation will include a description of your design (e.g. using diagrams) in each increment, difficulties encountered and solved in the design and implementation processes, tools used, advanced techniques supported by your DBMS, and a demonstration of your web application that is based on your DBMS.

Notes:

All modules developed will have an extensible design for further additions. All code will be fully documented. You may use any programming language that you wish.

Guidelines for evaluation:		***Marks***
1.	Regularity and progress of work	5
2.	Work knowledge and Involvement	5
3.	Semester End presentation and assesment	20
4.	Level of completion and demonstration of Functionality / Specifications	10
5.	Presentation style and content	10
	Total	**50**

References:

1. Smith, J. (2022). Comparative Analysis of NoSQL and MySQL in a Database Management System Project.
2. Retrieved from http://www.example.com/dbms_project
3. Hoffer, J. A., Ramesh, V., & Topi, H. (2019). Modern database management (13th ed.). Pearson.
4. Date, C. J. (2019). SQL & relational theory: How to write accurate SQL code (3rd ed.). O'Reilly Media

SEMESTER V

23-204-0501 COMPILER DESIGN

Course Outcomes:

On completion of this course the student will be able to:

1. Understand compilers, phases, lexical analysis, tokens, and lexical analyzer generators.
2. Analyse syntax analysis, context-free grammars, parsing techniques, LR parsers, parser generators.
3. Design syntax-directed translation, attributed definitions, translation strategies, type checking, runtime environments, storage management.
4. Evaluate intermediate code generation, optimization, data flow analysis, code generator design.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	1						2	3			
CO2	2	3	1	2	2							1	2			
CO3	3	3	3	3	2							1	3	2		
CO4	2	2	3	3	2							1	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Compiler: Introduction, Analysis of the source program, phases of a compiler, Lexical analysis: Role of the lexical analyser, Input Buffering, Specification of tokens, Recognition of tokens, Lexical analyser generators.

Module II

Syntax Analysis: Role of the parser, Context free grammars, Top down parsing, Bottom up parsing –Operator precedence parsing, LR parsers (SLR, Canonical LR, LALR) Parser generators.

Module III

Syntax directed translation, Syntax directed definitions, S attributed definitions, L attributed definition, Top down and bottom up translation, Type checking, Type systems, Specification of a type checker. Run time environment, Source language issues, Storage organization, Storage allocation strategies, Access to non-local names, Symbol tables.

Module IV

Intermediate code generation, Intermediate languages, Declarations, Assignment, Statement. Boolean Expression, Procedure calls, Code optimization: Introduction, Sources of optimization, Introduction to data flow analysis. Code generator: Issues in the design of a code generator, the target machine, A simple code generator.

References:

1. Aho, A. V., Sethi, R., & Ullman, J. D. (2006). Compilers principles, techniques, & tools (2nd ed.). Pearson.
2. Wilhelm, R., Seidl, H., & Hack, S. (2015). Compiler Design: Syntactic and Semantic Analysis, Springer-Verlag Berlin and Heidelberg GmbH & Co. K.
3. Louden, K. C. (1997). Compiler construction: Principles and practice. Thomson Learning.
4. Cooper, K. D., & Torczon, L. (2011). Engineering a compiler (2nd ed.). Morgan Kaufmann.
5. Muchnick, S. S. (1997). Advanced compiler design implementation. Morgan Kaufmann.
6. Holub, A. (1990). Compiler design in C. PHI.
7. Grune, D., Van Reeuwijk, K., Bal, H. E., Jacobs, C. J. H., & Langendoen, K. (2012). Modern Compiler design (2nd ed.). Springer.

23-204-0502 SOFTWARE DESIGN AND ARCHITECTURE

Course Outcomes:

On completion of this course the student will be able to:

1. Apply various architectural styles and patterns to design scalable and maintainable software systems.
2. Create software designs using UML diagrams.
3. Design software components and interfaces following best practices.
4. Critically assess real-world software architectures and identify areas for improvement.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	1			1		1		3	2	1	1	
CO2	3	3	3	2	1								2	1	1	
CO3	3	3	3	1	2			1	2	1		2	2	1		
CO4	3	3	3	2	1		1	1	1	1	1	2	2	1	1	

1-Slightly**; 2**-Moderately**; 3-**Substantially

Module I

Introduction to Unified Modeling Language (UML) and Unified Process (UP). UML diagrams: Structural and Behavioral Diagrams: Class diagrams, Object Diagrams, Component diagrams, Deployment diagrams, Package diagrams; Use case diagrams, Activity diagrams, Interaction diagrams, State machine diagrams.

Module II

Introduction to Design Patterns: Understanding of object-oriented design principles as a foundation for design patterns. Categories of design patterns (Creational, Structural, Behavioral), Design pattern selection and application in real-world scenarios. Importance of design patterns in software development. Refactoring code to improve design.

Module III

Introduction to software architecture: Definition and importance of software architecture, Role of the architect, Evolution of software architecture, Architectural Styles: Monolithic architecture, Client-server architecture, Layered architecture, Microservices architecture, Event-driven architecture, Component-based architecture.

Module IV

Architectural Analysis: Identifying architectural risks, Performance analysis, Security analysis, Usability analysis, Trade-off analysis. Case Studies and Real-World Applications: Analysis of existing software architectures, Success stories and failures, Emerging trends in software architecture.

References:

1. Mark Richards and Neal Ford. Fundamentals of Software Architecture: An Engineering Approach. O'Reilly Media; 1st edition (March 3, 2020).
2. Bass, L., Clements, P., & Kazman, R. (2021). Software architecture in practice Addison-Wesley Professional; 4th edition.
3. Arlow, J., & Neustadt, I. (2005). UML 2 and the Unified Process: Practical object-oriented analysis and design (2nd ed.). Addison Wesley.
4. Blaha, M., & Rumbaugh, J. (2007). Object oriented modeling and design with UML (2nd ed.). Pearson Education.
5. Larman, C. (2005). Applying UML and patterns: An introduction to object-oriented analysis and design and iterative development (3rd ed.). Prentice Hall.
6. Booch, G., & Rumbaugh, J. (2017). The unified modeling language user guide. Pearson.
7. Bruegge, B., & Dutoit, A. (2003). Object oriented software engineering: Using UML, patterns and Java (2nd ed.). Prentice Hall.
8. Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1994). Design patterns: Elements of reusable object-oriented software. Addison-Wesley Professional computing series.
9. Taylor, R. N., Medvidović, N., & Dashofy, E. M. (2010). Software architecture: Foundations, theory, and practice. John Wiley & Sons.
10. Martin, R. C. (2017). Clean architecture: A Craftsman's Guide to Software Structure and Design (1st ed.). Pearson Professional.
11. Braude, E. J. (2003). Software design: From Programming to Architecture (1st ed.). John Wiley & Sons.

23-204-0503 INTERNET OF THINGS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand IoT concepts, architecture, communication technologies, data analytics.
2. Construct IoT system, implement security controls using Python.
3. Analyse cloud integration for IoT data storage, processing, scalability.
4. Explore edge computing, advantages, and practical IoT applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	3	2							3	3	3	
CO2	3	3	2	3	3	2							3	3	3	
CO3	3	3	2	3	3	2							3	3	3	
CO4	3	3	2	3	3	2							3	3	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Internet of Things (IoT): Definition and characteristics of IoT, Components of IoT: Sensor, actuator, Gateway, Data storage, Logical design of IoT, IoT enabling Technologies. The core IoT functional stack, IoT Data management and compute stack.

Module II

Communication Technologies: Wi-Fi, Zigbee, 6LoWPAN, LoRa, NB-IoT, IoT protocols: HTTP, MQTT, CoAP, WebSocket, XMPP, AMQP. Identification protocols: IPv6, URI, Network architecture: WSN, 4G/5G network.
Data and analytics for IoT: An introduction to data analytics in IoT, Machine learning, supervised learning, unsupervised learning, neural networks, Big data analytics tools and technology, edge streaming analytics

Module III

Developing Internet of things: IoT design methodology, case study on IoT system for weather monitoring system. Python packages of interest for IoT.
IoT devices and endpoints: Raspberry Pi, Raspberry Pi interfaces, Experimental case study using Raspberry Pi and python. Python web application framework: Django, designing RESTful web API, amazon web services for IoT.

Module IV

Integration of IoT with Cloud Computing: Data Storage and Management, Data Processing and Analytics, Remote Monitoring and Control, Scalability and Elasticity. Edge Computing and its Role in IoT : Edge Devices and Gateways in IoT, Data Processing at the Edge, Latency Reduction and Performance Optimization, Edge Security and Privacy, Edge Computing Use Cases in IoT.
Security and privacy in IoT: IoT security threats, IoT security requirements, IoT security overview, security frameworks for IoT, privacy in IoT networks.

References:

1. Haynes, D., Salgueiro, G., Grossetete, P., Barton, R., & Henry, J. (2017). IoT fundamentals: Networking technologies, protocols, and use cases for the internet of things. Cisco Press.
2. Buyya, R., & Dastjerdi, A. V. (2016). Internet of Things: Principles and paradigms. Morgan Kaufmann.
3. Kamal, R. (2020). Internet of Things: Architecture and design principles. McGraw Hill Education.
4. Kumar, S. (2021a). Fundamentals of internet of things. CRC Press.
5. Raj, P., & Raman, A. C. (2017). The internet of things: Enabling Technologies, Platforms, and Use Cases. CRC Press.
6. Greengard, S. (2021). The internet of things (2nd ed.). MIT Press.

23-204-0504 BIG DATA ANALYTICS

Course Outcomes:

On completion of this course the student will be able to:

1. Establish Proficiency in Big Data Analytics Fundamentals.
2. Apply Data Engineering and Ingestion Techniques
3. Analyze Predictive Analytics and Machine Learning Models
4. Implement big data tools and technologies including Hadoop, MapReduce, Hive, Pig and NoSQL databases for storing, processing, and analyzing large datasets

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1	2								2	1	1	1
CO2	3	3	3				2				1		2	1	1	2
CO3	3	2	3	1	3		2				2		2	1		2
CO4	3	3	2	3	3						1		2	1	1	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Big Data Analytics: Big Data Overview, State of the Practice in Analytics, Key Roles for the New Big Data Ecosystem. Data Analytics Lifecycle: Overview, Discovery, Data Preparation, Model Planning, Model Building, Communicate Results, Operationalize.

Introduction to Data Engineering, Data Ingestion, Methods for collecting data from various sources (APIs, databases, file uploads etc.), Tools for data ingestion (Flume, Sqoop etc.), Real-time vs batch data ingestion, Handling different data formats (JSON, CSV, XML etc.), Data validation and error handling. Data Wrangling, Exploring and profiling raw data, Data cleaning techniques, dealing with missing data, transforming data (parsing, standardizing, normalizing etc.)

Module II

Clustering: Types of Clustering: Partitioning Clustering, Hierarchical Clustering. Distance Measures to Clusters: Scatter Coefficients, Single Linkage, Complete Linkage, Group Average Linkage,

Partitional Clustering: K-means Algorithm: Initialization Strategies, Optimization Objective, Iterative Optimization Process. Determining the Number of Clusters: Within Sum of Squares Metric (WSS), Elbow Method

Hierarchical Clustering: Agglomerative Clustering: Linkage Criteria, Dendrogram Construction, Dendrograms: Single Linkage Dendrograms, Complete Linkage Dendrograms

Association Rules: Overview: Definition and Importance. Applications. Apriori Algorithm: Generating Frequent Itemsets, Rule Generation, Evaluation of Candidate Rules: Support, Confidence. Validation and Testing:

Module III

Regression: Linear Regression, Overview of Gradient Descent for linear regression optimization. Logistic Regression, Additional Regression Models.

Classification models: Decision Trees: Entropy and Information gain as metrics, Construction of decision trees using the ID3 algorithm, KNN-classifier: Introduction to the K-Nearest Neighbors algorithm, Implementation and evaluation of KNN for classification tasks, Naïve Bayes: Overview of Bayes' Theorem, Understanding the Naïve Bayes algorithm for classification, Practical applications of Naïve Bayes in various contexts. Diagnostic of classifiers: Assessing model performance using precision, recall, F1 score, and ROC curves.

Module IV

Hadoop Ecosystem, Overview of Components of Apache Hadoop Ecosystem: Data storage, Data Processing, Data Access, Data Management. HDFS architecture: NameNode, Secondary NameNode, DataNode, Rack Aware Placement Policy. MapReduce: Phases of Map Reduce: Split, Map, Shuffle, and Reduce. Daemons of Map reduce: JobTracker and TaskTracker, Pig, Hive: Hive architecture overview. HBase, Mahout, NoSQL: Advantages and Disadvantages of NoSQL.

Case Studies for Assignment:

Case study using R: Clustering used in various domains like market segmentation, image segmentation/compression, anomaly detection, document clustering etc.

Case study using R with Matrix-based and Graph based visualization for top rules: Transactions in a Grocery store

References:

1. EMC Education Services. (2015). Data science and big data analytics: Discovering, analyzing, visualizing and presenting data. Wiley.
2. Reis, J., & Housley, M. (2022). Fundamentals of Data Engineering. O'Reilly Media, Inc.
3. Ryzko, D. (2020). Modern Big Data Architectures. Wiley.
4. Minelli, M., Chambers, M., & Dhiraj, A. (2013). Big data, big analytics: Emerging business intelligence and analytic trends for today's businesses. Wiley.
5. Baesens, B. (2014). Analytics in a big data world. The essential guide to data science and its applications. Wiley.
6. Davenport, T. H., & Harris, J. G. (2017). Competing on analytics: The new science of winning. Harvard Business Review Press.
7. Zikopoulos, P. C., & Eaton, C. (2012). Understanding big data. McGraw Hill.
8. White, T. (2015). Hadoop: The definitive guide (3rd ed.). O'Reilly Media, Inc.

23-204-0505 INTERNET ARCHITECTURE & DESIGN

Course Outcomes:

On completion of this course the student will be able to:

1. Understand Internet protocols, Ethernet, IP, ARP, ICMP for network troubleshooting.
2. Demonstrate network management with SNMP, RMON, DHCP, BOOTP, NAT.
3. Analyse advanced routing concepts like QoS, MPLS, BGP.
4. Explore multimedia traffic handling, client-server model, secure communication protocols.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		2	2	1	3					2	2			
CO2	3	2		2	2	1	3					2	2			
CO3	3	2	2	2	2	1	3					2	2			
CO4	3	2	2	2	2	1	3					2	2			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Internet: History of Internet, Internet Administration. Network Technologies: -WAN and LAN - Ethernet Technology: Fast and Gigabit Ethernet -10/100/1000 Ethernet - Properties of an Ethernet– Ethernet Hardware Addresses - Ethernet Frame Format, VLAN.

Design of Internet Addressing: Classful Internet Addresses: The Original Classful Addressing Scheme Dotted Decimal Notation – Subnet and Classless Extensions - CIDR Notation, IP Multicast Addresses.

Module II

ARP & RARP: Resolution through Direct Mapping - Resolution through Dynamic Binding - ARP Protocol Format- ARP Implementation- ARP Package: Cache Table, Queue, Output module, Input module, and Cache control module-. RARP. Introduction to ICMP, BOOTP, DHCP and NAT. Network Management: SNMP and RMON models.

Module III

Understanding Router Components: Ports- Queueing- Scheduling shaping-policing-marking. QoS in IP networks, Multiprotocol Label Switching (MPLS). Internet Routing Design: Routing Between Peers (BGP)-Routing Within An Autonomous System (RIP, OSPF). Internet Multicasting: Ethernet Multicast- IP Multicast- IGMP-DVMRP-PIM

Module IV

RSVP: Resource Reservation Protocol. Application layer & Client server model: Client server model, Concurrency, Socket Interface Introduction to Telnet, Rlogin, SSH & VPN.

Multimedia traffic over internet: Characteristics, Stream Control Transmission Protocol (SCTP)- Introduction, Services, Features, Packet format, RTP & RSTP protocols.

References:

1. Forouzan, B. A. (2022). Data Communications and Networking with TCP/IP Protocol Suite (6th ed.). McGraw-Hill
2. Comer, D. E. (2006). Internetworking with TCP/IP: Principles, protocols, and architecture (5th ed., Vol 1). Prentice Hall.
3. Ali, A. H. (2024). Network Architect's Handbook. Packt Publishing. Published on January 2024.
4. Kurose, J. F., & Ross, K. W. (2005). Computer networking: A top-down approach featuring the internet (3rd ed.). Pearson Education.
5. Comer, D. E. (2018). Computer networks and internets (6th ed.). Pearson Education.
6. Tanenbaum, A. S. (2003). Computer networks (4th ed.). Pearson Education.
7. Black, U. (2000). Internet Architecture: An Introduction to IP Protocols. Prentice Hall.
8. Kozierok, C. M. (2005). The TCP/IP guide: A Comprehensive, Illustrated Internet Protocols Reference. No Starch Press.

PROFESSIONAL ELECTIVE – I

23-204-0506(IE) AUGMENTED REALITY

Course Outcomes:

On completion of this course the student will be able to:

1. Understand VR concepts, components, features, input/output interfaces.
2. Analyse visual computation, stereoscopic displays, advanced rendering, interactive techniques.
3. Develop VR development tools, frameworks, applications in entertainment.
4. Explore AR/MR, technology, differences from VR, visualization, tracking, interactivity.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1						2	2	1		
CO2	3	2	2	3								2	3	3		
CO3	3	3	3	3	3	1						2	3	3		
CO4	3	3	3	3	3							1	3	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality. Primary Features and Present Development on Virtual Reality. Multiple Models of Input and Output Interface in Virtual Reality: Input -- Tracker, Sensor, Digital Glove, Movement Capture, Video-based Input, 3D Menus & 3DScanner Output --Visual /Auditory / Haptic Devices.

Module II

Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega, MultiGen, Virtools etc. Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR

Module III

Augmented Reality Technologies: Display technologies: optical see-through, video see-through,Tracking technologies: marker-based, markerless, sensor-based, Input technologies: gestures, voice, gaze, haptics, Software platforms and development tools (ARCore, ARKit, Vuforia, Unity, etc.). Design principles for AR applications, Legal and Ethical Considerations in AR

Module IV

Augmented and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

References:

1. Hale, K. S., & Stanney, K. M. (2014). Handbook of virtual environments: Design, implementation, and applications (2nd ed.). CRC Press. https://doi.org/10.1201/b17360
2. Bolter, J. D., Engberg, M., & MacIntyre, B. (2021). Reality media: Augmented and Virtual Reality. MIT Press.
3. Doerner, R., Broll, W., Grimm, P., & Jung, B. (2022). Virtual and Augmented reality (VR/AR): Foundations and Methods of Extended Realities (XR). Springer Nature.
4. Jerald, J. (2015). The VR book: Human-centered design for virtual reality. Association for Computing Machinery and Morgan & Claypool Publishers. https://doi.org/10.1145/2792790
5. Craig, A. B. (2013). Understanding augmented reality: Concepts and applications. Morgan Kaufmann. https://doi.org/10.1016/C2012-0-06211-0
6. Craig, A. B., Sherman, W. R., & Will, J. D. (2009). Developing virtual reality applications: Foundations of effective design. Morgan Kaufmann. https://doi.org/10.1016/B978-0-12-381542-1.00002-5

23-204-0507 DIGITAL MARKETING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental principles and strategies of Digital Marketing and analyse the concepts of display advertising.
2. Apply Search Engine Optimisation principles and road map for successful techniques in advertising.
3. Analyze the importance of Social media Platforms in Digital Marketing.
4. Understand the importance of web Analytics and identify the latest trends in Digital Marketing.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	1	2	1			1	3		1	3	2		2
CO2	2	1	3	2	2	1			1	3		1	3	2		2
CO3	2	1	2	1	2	2			1	3		1	3	2		2
CO4	2	1	2	1	2	1			1	3		1	3	3		3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Digital Marketing: Origin and development of Digital Marketing, Traditional Marketing and Digital Marketing, Digital Marketing Strategy, The P-O-E-M Framework, Integrated Marketing Communications, The digital landscape, Digital Marketing Plan. Concept of Display Advertising: Digital Metrics, What makes a good Ad, Targeting in Digital Marketing, Programmatic Digital Advertising.

Module II

Search Engine Optimization: Definition of SEM, Introduction to SEO, Search Engine Result Pages, Positioning, Search Behavior, SEO process and stages, On-page and Off-page SEO, paid Search Engine Marketing, pay-per-click (PPC) advertising, SWOT, Overview of Google Ads, Google AdWords.

Module III

Social Media Marketing: Social media strategy, Social media listening tools, Strategy, Implementation, Performance metrics, Social Media Marketing Tools, Facebook marketing, LinkedIn marketing, Instagram marketing. Case studies: The fall and rise of Maggi, Launch of CISCO ASR 1000 series routers.

Module IV

Web Analytics and Trends in Digital Marketing: Introduction to web analytics, web analytics approach, get to know your website, a model of analysis, log file analysis, page tagging, metrics and dimensions, interacting with data in google analytics. Email Marketing, Mobile Marketing, Video Marketing.

References:

1. Gupta, S. (2018). Digital marketing (2nd ed.). McGraw Hill Education (India) Private Limited.
2. Dodson, I. (2016). The art of digital marketing: The definitive guide to creating strategic, targeted, and measurable online campaigns. John Wiley & Sons.
3. Ahuja, V. (2019). Digital marketing: A practical approach (2nd ed.). Oxford University Press.
4. Ryan, D., & Jones, C. (2019). Understanding digital marketing: Marketing strategies for engaging the digital generation (5th ed.). Kogan Page.
5. Kingsnorth, S. (2022). Digital Marketing Strategy: An Integrated Approach to Online Marketing (3rd ed.). Kogan Page Publishers.
6. Chaffey, D., & Smith, P. (2022). Digital Marketing excellence: Planning, Optimizing and Integrating Online Marketing. Taylor & Francis.

23-204-0508 DIGITAL CANVAS

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the core concepts and vocabulary of UI/UX design
2. Design Interface elements and layouts following established design principles.
3. Gain a foundational understanding of a subject or tool
4. Communicate design ideas and concepts through wireframes and mock-ups.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3									2	1		
CO2	3	3	3	3	3								2	1		
CO3	2	2		3	1								2	1		
CO4	2	1	3	3	1					2			2	1		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Ideation, Articulation, Development, Planning, Testing, Researching, Mapping: Content and InteractionUser interface, Relationship between UI and UX, Roles in UI/UX, interface Conventions, Approaches to Screen based UI: Template, Content, Aesthetics and Functionality.

Module II

Formal Elements of an Interface: Look and Feel, Language as a design tool, Colour and Shape, image, Typography, Icons. Composing Interaction: Speed and style, Composition and Structure, Pattern library, Points of Interaction: Buttons, States and Changes

Module III

Hierarchy and Composition: Hierarchy of Content, structure and Grids, Platforms and Screen sizes, Navigational conventions: menus, buttons, and icons in different states.

Module IV

High Fidelity -wire frame- Figma Interface and Add a Frame-UI elements- Make Components-UI Kits-Design a User Interface with Simple Elements and Components

References:

1. Garrett, J. J. (2011). The elements of user experience: User-centered design for the web and beyond (2nd ed.). New Riders.
2. Hartson, R., & Pyla, P. S. (2012). The UX book: Process and guidelines for ensuring a quality user experience. Morgan Kaufmann. https://doi.org/10.1016/C2009-0-24166-8
3. Cooper, A. (2014). About face: The essentials of interaction design (4th ed.). Wiley.
4. McWade, J. (2006). Before & after graphics for business. Peachpit Press.
5. Babich, N. (2018, February 7). The 4 golden rules of UI design. Adobe Blog. https://theblog.adobe.com/4-golden-rules-ui-design/
6. Wong, E. (2018, July). Principle of consistency and standards in user interface design. Interaction Design Foundation. https://www.interaction-design.org/literature/article/principle-of-consistency-and-standards-in-user-interface-design
7. Branson, S. (2020). UX / UI Design: Introduction Guide To Intuitive Design And User-Friendly Experience.
8. Park, U. (2023). Introduction to design Thinking for UX beginners. Uijun Company.

23-204-0509 ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

Course Outcomes:

On completion of this course the student will be able to:

1. Explain different Problem-Solving strategies
2. Apply the First Order Logic approach to the fundamentals of computational intelligence
3. Analyze the structures and algorithms of a selection of techniques related to searching, reasoning and machine learning.
4. Understand and solve complex problems in Machine Learning Applications for image, video, & text.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1									2	2	1		
CO2	3	2	3	1								1	1	2		
CO3	2	2	2	1	1							1	2	1		
CO4	2	2	3	3	2							1	2	1		

1-Slightly**; 2**-Moderately**; 3-**Substantially

Module I

Artificial Intelligence: Introduction, Overview, Definition problem solving strategies, Classical approach for problem solving, Generate and Test Search Strategies, Uninformed search: Depth First Search, Breadth First Search, Branch and Bound. Informed search: Best First search, Greedy search, A* algorithm Iterative search: Hill Climbing. Adversarial search: MIN MAX algorithm, Alpha Beta pruning.

Module II

Knowledge Representation and Reasoning, Propositional logic, First order Logic, Resolution in propositional logic and First order logic. Probability Theory, Classical Probability Theory, Bayes' Rules, Bayesian Reasoning, Bayesian networks.

Module III

Machine learning paradigms: supervised, semi-supervised, unsupervised, reinforcement learning. Linear algebra and optimization. Regression: Linear regression with one variable, Linear regression with multiple variables, Basic idea of overfitting in regression, Ridge and lasso regression, Logistic regression. Performance measures: Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve (ROC), Area Under Curve (AUC).

Module IV

Dimensionality reduction: Principal Component Analysis. Linear Discriminant Analysis. Kernel methods, Support Vector Machines, Classification and Regression Trees, Multilayer Perceptron and Back propagation. Bayesian Belief Networks, Markov Random Fields, Exact inference methods, approximate inference methods.

References:

1. Grosan, C., & Abraham, A. (2011). Intelligent systems: A modern approach. Springer. https://doi.org/10.1007/978-3-642-21004-4
2. Rich, E., Knight, K., & Nair, S. B. (2009). Artificial intelligence (3rd ed.). McGraw-Hill.
3. Eberhart, R., & Shi, Y. (2007). Computational intelligence: Concepts to implementations. Morgan Kaufmann.
4. Engelbrecht, A. P. (2007). Computational intelligence: An introduction (2nd ed.). John Wiley & Sons. https://doi.org/10.1002/9780470512517
5. Neapolitan, R. E. J., & Jiang, X. (2020). Artificial intelligence: With an Introduction to Machine Learning, Second Edition. CRC Press.
6. Nagy, Z. (2018). Artificial intelligence and Machine learning fundamentals. Ingram short title.
7. Bernstein, P. (2022). Machine learning: Architecture in the Age of Artificial Intelligence (1st ed.). RIBA Publishing.

23-204-0510 NETWORKING & EDGE COMPUTING LAB

Course Outcomes:

On completion of this course the student will be able to:

1. Develop Socket programming and Routing algorithms.
2. Demonstrate the simulation of different networks using Network Simulators.
3. Develop IoT apps on Cooja
4. Develop Edge Computing applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	3				1	1		1	2	1		
CO2	2	3	2	3	3				1	1		1	2			
CO3	3	3	3	3	3				1	1		1	2	1		
CO4	3	3	3	3	3				1	1		1	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A: Networking Lab

- Familiarization/Introduction to:
  - Network components such as Modem, Gateways, Routers, Switches, Cables etc.
  - Various network softwares, services and applications.
  - Network troubleshooting techniques.
- TCP Socket Programming
- UDP Socket Programming
- TCP Client Server Communication
- UDP Client Server Communication
- Implementation of Routing algorithms
- Network Simulation using simulators like NS2 etc.

Part B: Edge Computing Lab

- Introduction to IoT and Edge Computing Simulators like NS3, Cooja etc.
- Developing IoT Applications: Develop an application to collect and visualize real time sensor data.
- Developing Edge Applications: Develop an application to process data at the edge before sending to cloud
- Deploy a machine learning model on the edge device. Test model by running real-time inference on the RPi and LoRaWAN.

References:

1. Forouzan, B. A., & Fegan, S. C. (2007). Data communications and networking (4th ed.). McGraw-Hill
2. Johnson, M. R. (2019). NS2 Simulation: A Comprehensive Guide. TechBooks Publishing..
3. Kurose, J. F., & Ross, K. W. (2013). Computer networking: A top-down approach (6th ed.). Pearson.
4. Shi, W., & Dustdar, S. (2016). The promise of edge computing. Computer, 49(5), 78–81. https://doi.org/10.1109/MC.2016.145
5. Porambage, P., Braeken, A., Liyanage, M., Gurtov, A., & Ylianttila, M. (2021). The roadmap to 6G security and privacy. IEEE Access, 9, 108515–108544. https://doi.org/10.1109/ACCESS.2021.3111782
6. Cavaiani, T. (2009). IT networking labs. Pearson.
7. Bhadauria, A. (2022). Edge Computing with Python: End-to-end Edge Applications, Python Tools and Techniques, Edge Architectures, and AI Benefits (English Edition). BPB Publications.

23-204-0511 SOFTWARE ENGINEERING LAB

Course Outcomes:

On completion of this course the student will be able to:

1. Perform Object-Oriented analysis and design for problem specifications, identifying and mapping software requirements using UML modeling.
2. Apply design patterns to improve software quality and justify the rationale behind specific pattern choices.
3. Draw standard UML diagrams using a modeling tool for given case studies, map design to code, and implement a three-layered architecture.
4. Test code compliance with SRS, validate requirements satisfaction.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	3	2	1	3	3	3	2	2	2		
CO2	2	3	3	3		3	2	1	3		3		2	2		
CO3	2	2	3	2	3	3	2	1	3		3		2	2		
CO4	2	2	3	3	2	3	2	1	3	3	3	2	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Instructions

1. Suggested domains from mini project (DBMS BASED)
2. Identify a software system that needs to be developed.
3. Document the Software Requirements Specification (SRS) for the identified system.
4. Identify use cases and develop the Use Case model.
5. Identify the conceptual classes and develop a Domain Model and also draw a Class Diagram from that.
6. Using the identified scenarios, find the interaction between objects and represent them using UML Sequence and Collaboration Diagram. Draw relevant State Chart and Activity Diagrams for the same system.
7. Implement the system as per the detailed design
8. Test the software system for all the scenarios identified as per the use case diagram
9. Improve the reusability and maintainability of the software system by applying appropriate design patterns.
10. Implement the modified system and test it for various scenarios

References:

1. Arlow, J., & Neustadt, I. (2005). UML 2 and the unified process: Practical object oriented analysis and design (2nd ed.). Addison Wesley.
2. Blaha, M., & Rumbaugh, J. (2005). Object oriented modeling and design with UML (2nd ed.). Pearson Education.
3. Larman, C. (2005). Applying UML and patterns: An introduction to object oriented analysis and design and iterative development (3rd ed.). Prentice Hall.
4. Sorvisto, D. (2023). MLOPs Lifecycle Toolkit: A Software Engineering Roadmap for Designing, Deploying, and Scaling Stochastic Systems. Apress.
5. Cooling, J. (2019). The complete edition - Software Engineering for Real-Time Systems. Packt Publishing Limited.

23-200-0512 INTERNSHIP-II

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject of area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organization of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1			2	1		2	2	2	1	2
CO2	2	3	1	2	2	1			2	2	1	1	2	2		1
CO3	2	2	3	2	2	1			2	2	1	1	2	2		2
CO4	2	2	2	3	2	1			2	2	1	1	2	2		1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Internship Guidelines

- An internship plan has to be prepared by the interns incorporating the job description/internship duties, name of the project, if any and internship schedule and expected learning outcomes in consultation with industry supervisor/mentor and institute faculty.
- A detailed training report in the prescribed format shall be submitted at the end of the internship.
- Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
- The work shall be reviewed and evaluated periodically.
- Orientation of interns, resource requirement of interns, monitoring of interns progress on a daily basis shall be carried out by the industry offering internship in addition to ensuring safety and welfare of the interns

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of the internship	10
5.	Internship Report – Presentation style and content	10
Total		**50** Marks

SEMESTER VI

23-204-0601 AGILE PROJECT METHODOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. Learn the principles behind the agile approach to software development
2. Enable them to positively contribute as an agile team member with a better understanding of various phases.
3. Develop a more advanced, applied level of knowledge to gain an understanding of Agile and the ability to apply relevant project management methods, leading to successful Agile projects.
4. Learn the different management styles needed for successful Agile projects compared to traditional projects.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1							2		2	1		
CO2	3	2	3						1		3	1	2	2		
CO3	3	3	3	2	3				3		2		2	3		2
CO4	3	3	1	3				3	3		3	2	3	2		3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

The Agile Manifesto, Key values and principles, Agile vs traditional approaches, Benefits and challenges
The Agile Revolution, Agile Business Objectives, Agility Defined, Agile Leadership Values, Agile Performance Measurement, Iterative, Feature-Based Delivery Teams over Tasks , Leading Teams , Building Self-Organizing (Self-Disciplined) Teams , Participatory Decision Making.

Module II

An Agile Project Management Model, An Agile Enterprise Framework, An Agile Delivery Framework The Envision Phase, Product Vision , Project Objectives and Constraints , Project Community.

Module III

The Speculate Phase , Speculating on Product and Project , User stories and Product Backlog , Release and iteration planning, Advanced Release Planning , Release (Project) Planning , Wish-based Planning (Balancing Capacity and Demand) , Capabilities , Value Point Analysis.

Module IV

Agile Techniques, Scrum and Kanban, Extreme Programming (XP), Lean development, DevOps culture
A/B Testing, Multivariate Testing, B2C Development, Fail fast mindset, Scaling agile

References:

1. Highsmith, J. (2010). Agile project management: Creating innovative products (2nd ed.). Addison-Wesley.
2. Shore, J., & Warden, S. (2021). The Art of Agile Development (2nd ed.). O'Reilly Media, Inc.
3. Layton, M. C., Ostermiller, S. J., & Kynaston, D. J. (2020). Agile project management for dummies. John Wiley & Sons (3rd ed.).
4. Galvin, B. (2020). Agile Project Management: Beginner's Guide to Agile Project Management and Software Development.
5. Shore, J., & Warden, S. (2008). The art of agile development. O'Reilly Media.
6. Martin, R. (2003). Agile software development: Principles, patterns, and practices. Prentice Hall.
7. Cohn, M. (2010). Succeeding with agile: Software development using Scrum. Addison- Wesley.
8. Cockburn, A. (2006). Agile software development (2nd ed.). Addison-Wesley
9. Agile Manifesto - http://agilemanifesto.org.

23-204-0602 DATA SECURITY AND CRYPTOGRAPHY

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental security goals and identify various security attacks.
2. Analyse symmetric block ciphers, with a focus on the DES and AES algorithms.
3. Apply public key cryptography principles for key management.
4. Identify various methods to ensure message authentication and integrity.
5. Explore different aspects of system security, including intruders and malicious codes.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2									2	2	3	
CO2	3	2	2	2									2	2	3	
CO3	2	2	2	2									2	2	3	
CO4	2	2	2	2									2	2	3	
CO5	1	1	1	1									2	2	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction: Security goals- confidentiality, integrity, availability. Security attacks Cryptography: Symmetric encryption principles, Symmetric block cipher: DES algorithm, AES algorithm, confusion, diffusion, avalanche effect

Module II

Introduction to Number Theory, Prime Factorisation, Fermat's Theorem, Euler's Theorem, Extended Euclidean Algorithm, Primitive Roots, Discrete Logarithms.
Public key Cryptography, Principles of Public key Cryptography Systems, RSA algorithm
Key Management: Key distribution for asymmetrical systems, Diffie Hellman Key Exchange.

Module III

Message Authentication Requirements, Authentication functions, Message authentication codes, Hash functions, Secure Hash Algorithm.
Digital signatures protocols: Digital signature standards, Digital Certificates, DSA algorithm.

Module IV

System security: Malicious software: Types of Malicious software, propagation, countermeasure, Intruders: Intrusion Detection, Password Management, DDoS attacks.

References:

1. Stallings, W. (2017). Network security essentials: Applications and standards (6th ed.). Pearson Education.
2. Pfleeger, C., Pfleeger, S., & Coles-Kemp, L. (2023). Security in computing (6th ed.). Addison-Wesley Professional.
3. Jarmul, K. (2023). Practical data privacy: Enhancing Privacy and Security in Data. O'Reilly Media.
4. Forouzan, B. A., & Mukhopadhyay, D. (2015). Cryptography & network security (3rd ed.). Tata McGraw Hill.
5. Calabrese, T. (2010). Information security intelligence: Cryptographic principles & applications. Thomson Learning

23-204-0603 DEEP LEARNING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental principles, theory and approaches for learning with deep neural networks
2. Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
3. Fit within the context of other ML approaches and what learning tasks it is considered to be suited and not well suited to perform.
4. Implement deep learning algorithms and solve real world problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	1								2	2	2		
CO2	2	1	2	2								2	2	2		
CO3	1	1	2	3								2	2	2		
CO4	1	1	1	2								2	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Neural Networks: The Biological Neuron, The Perceptron, Multilayer Feed Forward Networks, Training Neural Networks, Backpropagation Learning, Activation Functions, Linear, Sigmoid, Tanh Hard, Tanh SoftMax, Rectified Linear Loss Functions, Loss Function Notation, Loss Functions for Regression, Loss Functions for Classification, Loss Functions for Reconstruction, Hyper parameters, Learning Rate, Regularization, Momentum, Sparsity.

Module II

Deep Networks: Deep Learning, Common Architectural Principles of Deep Networks, Parameters, Layers, Activation Functions, Loss Functions, Optimization Algorithms, Hyper parameters, Summary, Building Blocks of Deep Networks, RBMs Autoencoders, Variational Autoencoders.

Module III

Unsupervised Pretrained Networks: Deep Belief Networks, Generative Adversarial Networks.
Convolutional Neural Networks (CNNs): Biological Inspiration, Intuition, CNN Architecture Overview, Input Layers, Convolutional Layers, Pooling Layers, Fully Connected Layers, Other Applications of CNNs.

Module IV

Recurrent Neural Networks, Modeling the Time Dimension, 3D Volumetric Input, Why Not Markov Models? General Recurrent Neural Network Architecture, LSTM Networks, Domain Specific Applications and Blended Networks. Recursive Neural Networks, Network Architecture, Varieties of Recursive Neural Networks, Applications of Recursive Neural Networks

References:

1. Patterson, J., & Gibson, A. (2017). Deep learning: A practitioner's approach. O'Reilly Media, Inc.
2. Buduma, N. (2021). Fundamentals of deep learning: Designing Next-Generation Machine Intelligence Algorithms (2nd ed.). O'Reilly Media.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2023). Deep learning. Alanna Maldonado.
4. Yegnanarayana, B. (2009). Artificial neural networks. PHI Learning Pvt. Ltd.

23-204-0604 CLOUD COMPUTING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental concepts and technologies of distributed systems and cloud computing, including system models, enabling technologies, and virtualization.
2. Develop cloud-native applications using parallel and distributed programming paradigms, such as MapReduce and Hadoop, and deploy them on cloud platforms.
3. Design and implement cloud-based solutions using various service models (IaaS, PaaS, SaaS) and platforms (Google App Engine, Amazon AWS, Microsoft Azure, IBM Blue Cloud).
4. Understand cloud security principles and trust management, implement security measures for cloud applications, and manage cloud resources effectively..

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1										2	2		1
CO2	2	3	3	2	3		2						2	3		2
CO3	2	2	3	3	3								2	2		
CO4	2	2	2	1	3	3	3				3		2			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Distributed System Models and Enabling Technologies: Scalable Computing over the Internet-Technologies for Network - Based Systems-System Models for Distributed and Cloud Computing-Software Environments for Distributed Systems and Clouds - Performance, Security, and Energy Efficiency in Distributed Computing.

Module II

Virtual Machines and Virtualization of Clusters and Data Centres: Implementation Levels of Virtualization - Virtualization Structures/Tools and Mechanisms - Virtualization of CPU, Memory, and I/O Devices - Virtual Clusters and Resource Management - Virtualization for Data Centre Automation.
Case study: Virtualization Software-VMware

Module III

Introduction to Cloud Computing: Cloud issues and challenges - Properties - Characteristics - Service models-Deployment models.Cloud resources: Network and API - Virtual and Physical computational resources - Data-storage. Service models: Infrastructure as a Service (IaaS) ,Resource Virtualization (Server, Storage, Network)-Platform as a Service (PaaS), Cloud platform & Management (Computation, Storage), -Software as a Service (SaaS),Web services, Web 2.0 .
Case Study - Google App Engine, Amazon AWS, Microsoft Azure, IBM Blue Cloud.

Module IV

Cloud Programming and Software Environments: Cloud Capabilities and Platform Features- Parallel and Distributed Programming paradigms – Case study: MapReduce, Hadoop
Cloud Security and Trust Management: Authentication, Authorization, and Accounting -Cloud Security Defence Strategies- Distributed Intrusion/Anomaly Detection- Data and Software Protection Techniques- Reputation-Guided Protection of Data centers.

References:

1. Hwang, K., & Fox, G. C. (2012). Distributed and cloud computing: From parallel processing to the Internet of things. Morgan Kaufmann. https://doi.org/10.1016/C2011-0-07288-1
2. Erl, T., & Monroy, E. B. (2023). Cloud computing: Concepts, Technology, Security, and Architecture. Pearson.
3. Marinescu, D. C. (2022). Cloud Computing: Theory and Practice (3rd ed.). Morgan Kaufmann.
4. Misra, R. (2020). Cloud and distributed computing: Algorithms and Systems. Wiley.
5. Buyya, R., Broberg, J., & Goscinski, A. (2011). Cloud computing: Principles and paradigms. John Wiley & Sons. https://doi.org/10.1002/9780470940105
6. Furht, B. (2010). Handbook of cloud computing. Springer. https://doi.org/10.1007/978-1-4419-6524-0

23-204-0605 DESIGN AND DEVELOPMENT OF MOBILE APPLICATION

Course Outcomes:

On completion of this course the student will be able to:

1. Understand mobile app considerations, architectures, connection types, synchronization, design principles.
2. Explore mobile app design, UI, content, user experience, client types, data transfer.
3. Study Android app development, architecture, Android Studio, app anatomy, lifecycle, state management.
4. Expertise in Flutter, widgets, lifecycle events, trees, Dart features and develop a mobile app.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1		2							1	3	2		
CO2	2	3	3	3	2							1	3	2		
CO3	2	2	3	2	3							1	3	3		
CO4	2	2	3	3	3							1	3	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction: Mobility, Developing Mobile Applications: Considerations and Fallacies. Mobile Application Architectures: Client - Server, One - Tier, Two - Tier, Three - Tier Architectures. Connection Types, Synchronization, Good Architectural Design Tenets.

Module II

Mobile Application Design: Mobile Client User Interface - characteristics, Application Content, User Experience, Best Practices.
Mobile Client Applications - Thin Client, Fat Client, Web Page Hosting. Client - Server Data Transfer: HTTP, HTML, WAP, WML.

Module III

Android Applications: An overview of Android Architecture, Anatomy of an Android Application, Android Studio - Setting up Android Studio Development Environment, Creating an Example Android App in Android Studio, Android Studio User Interface, Creating an Android Virtual Device (AVD), Android Debug Bridge (ADB), Understanding Android Application and Activity Lifecycles, Activity class, Dynamic state and persistent state, Android Activity Lifecycle methods, Activity Lifetimes, Saving and restoring activity state, Bundle class.

Module IV

Flutter- Introducing Flutter, Widgets and Elements, understanding widget lifecycle events, Understanding the widget tree and the element tree, Features of Dart.
Creating an Example Android App using Flutter.

References:

1. Lee, V., Schneider, H., & Schell, R. (2004). Mobile applications: Architecture, design, and development. Prentice Hall.
2. Smyth, N. (2020). Android Studio 4.0 Development Essentials - Java Edition: Developing Android Apps Using Android Studio 4.0, Java and Android Jetpack..
3. Bailey, T., & Biessek, A. (2021). Flutter for Beginners - Second Edition: An Introductory Guide to Building Cross-platform Mobile Applications with Flutter 2.5 and Dart. Packt Publishing.
4. Napoli, M. L. (2019). Beginning flutter: A hands on guide to app development. John Wiley & Sons.
5. Iversen, J., & Eierman, M. (2014). Learning mobile app development: A hands-on guide to building apps with iOS and Android. Addison-Wesley.

PROFESSIONAL ELECTIVE – II

23-204 -0606(IE) DevOps ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Comprehend the core principles of DevOps and its benefits in modern software development. Along with the relationship between DevOps and Agile methodologies, recognizing how they complement each other.
2. Expertise in designing and implementing Continuous Integration / Continuous Deployment (CI/CD) pipelines
3. Evaluate different application architectures (microservices, monoliths) familiarize the implementation of frameworks TDD and BDD to ensure the quality of applications.
4. Master the concepts of containerization using Docker and understand the benefits and challenges associated with containerization and virtualization technologies, and be able to install Docker across multiple operating systems.
5. Acquire skills in leveraging cloud services and models, and be able to integrate cloud services into the DevOps workflow and deploy applications effectively in cloud environments.
6. Understand information security principles (ethical hacking, cybersecurity etc.) and apply security measures throughout the SDLC along with implementing risk management strategies to mitigate security threats effectively

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				3					3		3			
CO2	1	3			3								2	3		
CO3	1	2	3		3								3			
CO4	2	3	3		3								2	2		
CO5	3	2			3								2	2		3
CO6	3		3	3									2		3	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to DevOps: What is Devops, Benefits of DevOps, Principles of DevOps, Relationship with Agile and DevOps, Challenges with the Traditional Approach, DevOps Approach to the challenges, CI/CD Pipeline

Module II

Overview of Modern Application Development: Micro services, Monoliths, API, Pros & Cons of Micro services. Software and Automation Testing Framework: Test-Driven Development Approach, Behavior Driven Development Approach.

Module III

Overview of Containerization: Introduction to Docker Containers, Development of Containerized Application, Benefits and overheads of Containerization. Overview of Virtualization, Docker installation on Multiple OS

Module IV

Cloud in DevOps : Cloud Services and Models, Case study Using AWS in DevOps Information Security: Ethical hacking, Cyber security and information Security, Service Development Life Cycle, Threat Modeling and Risk Management..

References:

1. Kim, G., Debois, P., Humble, J., Willis, J., & Forsgren, N. (2021). The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations. It Revolution Press.
2. Gift, N., Behrman, K., & Deza, A. (2020). Python for DevOps: Learn Ruthlessly Effective Automation. O'Reilly.
3. Davis, J., & Daniels, R. (2016). Effective DevOps: Building a culture of collaboration, affinity, and tooling at scale. O'Reilly Media, Inc.
4. Kim, G., Humble, J., Debois, P., & Willis, J. (2018). The phoenix project: A novel about IT, DevOps, and helping your business win. IT Revolution Press.
5. Morris, K. (2016). Infrastructure as code: Managing servers in the cloud. O'Reilly Media, Inc.

23-204 -0607 MOBILE COMPUTING TECHNOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. Learn the basics of mobile communications and evolution of different generations of cellular networks.
2. Understand the different architectures of mobile computing and their applications.
3. Analyse the working of mobile IP, mobile web services and mobile data management.
4. Learn about wireless security in WLAN and mobile networks.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1		2		2						2			
CO2	3	1	3				1						2	1		
CO3	3	3	2	1									2	2		
CO4	2	1	2										2		2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Mobile communication basics: Antenna, Modulation, Multiplexing, Spread Spectrums. Cellular network- First Generation Networks-Second generation (2G): GSM-CDMA network, data over cellular network-2.5G network-GPRS, Third generation network (3G) network, introduction to 4G and 5G systems

Module II

Emerging wireless networks: MANET, Wireless sensor networks-OFDM and Flash OFDM Mobile computing architecture: Wireless LANs, WAP, Wireless Personal Area Network,
Pervasive computing, Mobile Devices, cards and sensors, Mobile computing applications

Module III

Mobile IP, wireless web-Web services and mobile web services- Wireless middleware-wireless gateway and mobile application servers, Mobile database management, Smart Client, Data Store, Application.

Module IV

Wireless security-WLAN security-cellular wireless network security-Mobile ad-hoc network security-Internet security protocols: VPNs and IPSec-Wireless middleware security-SSL for wireless web security-WAP security and WTLS.

References:

1. Kamal, R. (2019). Mobile computing (3rd ed.). Oxford University Press.
2. Anderson, J. (2020). Mobile computing: technology and applications. Clanrye International.
3. Stallings, W. (2009). Wireless communications & networks (2nd ed.). Pearson.
4. Tanenbaum, A. S., & Wetherall, D. (2011). Computer networks (5th ed.). Pearson.
5. Singh, K. D. (2015). Mobile computing (2nd ed.). Oxford University Press.
6. Javid, P. A., Qadri, Y. A., & Amjad, A. (2014). Mobile computing and wireless networks: Concepts, methodologies, tools, and applications. IGI Global. https://doi.org/10.4018/978-1-4666-6071-7
7. Ghosh, A. K., & Raj, S. (2015). Fundamentals of LTE. Pearson Education India.
8. Dahlman, E., Parkvall, S., & Sköld, J. (2016). 5G NR: The next generation wireless access technology. Academic Press. https://doi.org/10.1016/C2017-0-03306-1
9. Banerjee, P., Choudekar, P., & Muju, M. K. (2013). Mobile Web Services. Springer Science & Business Media. https://doi.org/10.1007/978-1-4471-5017-4

23-204-0608 RECOMMENDER SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the concept of recommender systems in online platforms.
2. Apply data mining and machine learning concepts for recommender system design.
3. Analyze and evaluate recommendation accuracy.
4. Evaluate various recommendation algorithms.
5. Identify the various security aspects of recommender systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3				3	1							2	1		
CO2	3	3	3		3								2			
CO3	2	3	2	3	3								2	3		
CO4	2	3	3	1	3								2	2		
CO5	2	3				3		3					2		2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to basic concepts, Need for recommender systems, Prediction vs Recommendations. Collaborative Recommendations: user based nearest neighbor recommendation, item based nearest neighbor recommendation, model based and preprocessing based approach, types of ratings, data sparsity, cold start problem, advantages and disadvantages of collaborative filtering. Case Study: Amazon Recommender System.

Module II

Content Based Recommendation: content representation and content similarity, similarity-based retrieval, other text classification methods. Case Study: Movie Recommender System.

Knowledge based recommendation: Knowledge representation and reasoning, Interacting with constraint based recommenders, Interacting with case based recommenders Case Study: Entree Restaurant Recommendation System

Module III

Hybrid recommendation approaches: Opportunities for hybridization, Monolithic hybridization design, Parallelized hybridization design, Pipelined hybridization design.

Explanations in recommender systems: Explanations in constraint-based recommenders, Explanations in case based recommenders, Explanations in collaborative filtering recommenders.

Module IV

Evaluating recommender systems: General properties of evaluation research, Popular evaluation designs, Evaluation on historical datasets, Case study: Personalized game recommendations on the mobile Internet. Attacks on Collaborative Recommender Systems:

Types of attacks, evaluation of effectiveness and countermeasures. Recommendations in ubiquitous environments

References:

1. Jannach, D., & Zanker, M. (2010). Recommender systems: An introduction. Cambridge University Press. https://doi.org/10.1017/CBO9780511763113
2. Kumar, P. P., Vairachilai, S., Potluri, S., & Mohanty, S. N. (2021). Recommender Systems. CRC Press.
3. Falk, K. (2019). Practical Recommender systems. Manning Publications.
4. Aggarwal, C. C. (2016). Recommender Systems: The Textbook. Springer.
5. Bhasker, B., & Srikumar, K. (2010). Recommender systems in e-commerce. Tata McGraw Hill Education.
6. Santos, O. C., & Boticario, J. G. (Eds.). (2011). Educational recommender systems and technologies: Practices and challenges. IGI Global. https://doi.org/10.4018/978-1-60960-479-0
7. Robillard, M. P., Maalej, W., Walker, R. J., & Zimmermann, T. (Eds.). (2014). Recommendation systems in software engineering. Springer. https://doi.org/10.1007/978-3-642-45135-5
8. Aggarwal, C. C. (2016). Recommender systems: The textbook. Springer. https://doi.org/10.1007/978-3-319-29659-3

23-204-0609 MINING OF MASSIVE DATASETS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the basics of data mining and its limitations.
2. Gain knowledge about data mining streams and clustering algorithms for data mining.
3. Implement algorithms using map reduce.
4. Explore the recommendation system.
5. Analyse large scale machine learning systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1										1	3	1		
CO2	2	1	2	1	1							2	3	1		
CO3	2	3	3	3	3							2	3	1		
CO4	2			3								2	3	1		
CO5	2	2	3									2	3	1		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Data Mining-What is data mining? - Bonferroni's Principle- Distributed File Systems – Physical Organization of Compute Nodes-Large-Scale File-System Organization. Map Reduce- The Map Tasks-Grouping by Key-The Reduce Tasks-Combiners-Details of MapReduce Execution-Coping With Node Failures. Frequent Itemsets - Definition-Applications- Association Rules. Market Baskets and the A-Priori Algorithm - Representation of Market-Basket Data-The A-Priori Algorithm. Handling Larger Datasets in Main Memory-The Multistage Algorithm-The Multihash Algorithm.

Module II

Algorithms Using MapReduce-Matrix-Vector Multiplication by map Reduce-Relational-Algebra Operations-Computing Selections by MapReduce-Computing Projections by MapReduce-Union, Intersection, and Difference by MapReduce-Computing Natural Join by MapReduce-Grouping and Aggregation by MapReduce-Matrix Multiplication. Locality-Sensitive Hashing for Documents. Distance Measures-Euclidean Distances -Jaccard Distance- Cosine Distance - Hamming Distance.

Module III

Mining Data Streams: The Stream Data Model-A Data-Stream-Management System-Examples of Stream Sources - Stream Queries-Issues in Stream Processing. PageRank. Clustering-Introduction to Clustering Techniques-Hierarchical Clustering-K-means Algorithms-The CURE Algorithm. Mining Social-Network Graphs-Social Networks as Graphs - Clustering of Social-Network Graphs-The Girvan-Newman Algorithm

Module IV

Recommendation Systems-A Model for Recommendation Systems-Content-Based Recommendations. Large-Scale Machine Learning-The Machine-Learning Model- Perceptron, Support-Vector Machines, Learning from Nearest Neighbors.

References:

1. Leskovec, J., Rajaraman, A., & Ullman, J. D. (2020). Mining of massive datasets (3rd ed.). Cambridge University Press. https://doi.org/10.1017/9781108639044
2. Han, J., Pei, J., & Tong, H. (2022). Data mining: Concepts and Techniques. Elsevier.
3. Tan, P.-N., Steinbach, M., Karpatne, A., & Kumar, V. (2019). Introduction to data mining (2nd ed.). Pearson.
4. Han, J., Pei, J., & Kamber, M. (2011). Data mining: Concepts and techniques (3rd ed.). Morgan Kaufmann. https://doi.org/10.1016/C2009-0-61819-5
5. Aggarwal, C. C. (2015). Data mining: The textbook. Springer. https://doi.org/10.1007/978-3-319-14142-8
6. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). Data mining: Practical machine learning tools and techniques (4th ed.). Morgan Kaufmann.
7. Zaki, M. J., & Meira Jr, W. (2014). Data mining and analysis: Fundamental concepts and algorithms. Cambridge University Press. https://doi.org/10.1017/CBO978051181139

23-204-0610 CLOUD AND DATA ANALYTICS LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Learn the basics of Linux OS commands
2. Analyse cloud architecture
3. Develop and run virtual machines on opensource OS
4. Implement Infrastructure, Storage as a Service.
5. Install and analyses security features for cloud.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1			1				1			1	3	1		
CO2	2	1	2	2	1				1	1		2	3	1		
CO3	2	1	3	3	2				1	1		2	3	1		
CO4	2		3	3	3				1	1		2	3	1		2
CO5	2		2	3	3				1	1		2	3	1	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A

Students will complete the following set of experiments in lab to get familiarized to Python language:

1. Programs to demonstrate Variables, Data Types, I/O and Import and Operators.
2. Programs to demonstrate flow control using if else and looping statements.
3. Program to demonstrate functions in python, arguments, recursion and anonymous functions.
4. Program to demonstrate modules and packages in python.
5. Program to demonstrate file handling operations and exception handling.
6. Program to demonstrate multi threaded programming using Python.

Part B

1. Find a procedure to launch virtual machine using trystack (Online Openstack Demo Version)
2. Install Virtualbox/VMware Workstation with different flavours of Linux or Windows OS on top of windows.
3. Install a C compiler in the virtual machine created using virtual box and execute Simple Programs
4. Install Google App Engine. Create hello worldapp and other simple web applications using python/Java.
5. Use GAE launcher to launch the web applications.
6. Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim
7. Find a procedure to transfer the files from one virtual machine to another virtual machine.
8. Install Hadoop single node cluster and run simple applications like word count.

Part C

Programming in Distributed environment.
(Implementations may be done using Python, Scala or Java.)

Set I

1. Resilient Distributed Dataset operations and passing functions
2. Working with Key/Value Pairs and transformations
3. Broadcast Variables and Piping to External Programs
4. Using Spark SQL in Applications'
5. Installing Message Passing Interface (MPI) for demonstrating Distributed computing.
6. Demonstrating Distributed applications using Pyro or Python RQ.

Set II

1. Set up some pre-installed programs and infrastructure to see how to run programs in the cloud.
2. Programming in MapReduce/Spark to study scalability. Typical problems are from matrix multiplication, text processing, graphs , web crawling, and the like
3. Programming frameworks such as Map-Reduce or Spark, how to write programs in these programs, features such as fault-tolerance, using commodity hardware,
4. Illustrate the differences between Map-Reduce style programming and C-style programming

References:

1. White, T. (2015). Hadoop: The definitive guide (4th ed.). O'Reilly Media, Inc
2. Rioux, J. (2022). Data Analysis with Python and PySpark. Manning.
3. Motwani, B. (2020). Data Analytics using Python. Wiley.
4. Kamal, R., & Saxena, P. (2019). Big Data Analytics: Introduction to Hadoop, Spark, and Machine-Learning. McGraw Hill Education.
5. Grover, M., & Malaska, T. (2015). Hadoop application architectures. O'Reilly Media, Inc.
6. Karau, H., & Konwinski, A. (2015). Learning spark: Lightning-fast big data analysis. O'Reilly Media, Inc.
7. Ryza, S., Laserson, U., Owen, S., & Wills, J. (2015). Advanced analytics with Spark. O'Reilly Media, Inc.
8. Pierfederici, F. (2016). Distributed computing with python. Packt Publishing Ltd.

23-204-0611 MINI PROJECT-MOBILE APP DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Develop a mobile application with a good understanding of the services that they have used in their project.
2. Demonstrate the installation and configuration of various mobile application development tools.
3. Apply mobile application models/architectures and patterns to the development of a mobile software application.
4. Describe the components and structure of a mobile development framework.
5. Apply a mobile development framework to the development of a mobile application.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3	3				1	2		1	3	3		
CO2	2	1	1		3				1	2		1	3	3		
CO3	2	3	3	3	3				1	2		1	3	3		
CO4	2	1	1		3				1	2		1	3	3		
CO5	2	3	3	3	3				1	2		1	3	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A

Students will complete the following set of experiments in lab to get familiarized to mobile application development:

1. Installation and Setting up of the development IDE and required tools.
2. Creation of an "Hello World" application.
3. An application to demonstrate different components of the user interface.
4. An application to demonstrate interaction in an UI interface using Button, Textbox etc.
5. An application to demonstrate navigation between different user interface layouts.
6. An application to demonstrate data transfer.
7. An application to demonstrate the use of a database management system.
8. Study of Cross-Platform development of mobile applications using frameworks such as Flutter, React Native etc.

Part B

Students shall develop an application making use of minimum of three services from the following list:
Multimedia Animations, Audio Capture, Audio Manager, Camera, Image Effects, Image Switcher, Media Player, Jet Player, Networking Bluetooth, Network Connection, SIP Protocol, WiFi, Social Services Facebook Integration, Google Maps LinkedIn Integration, Twitter Integration, User Interface Auto Complete, Multitouch, Clipboard, Custom Fonts, Gestures, UI Design, UI Patterns, UI Testing, Database, PHP/MySQL, Data Backup, SQLite Database, Internal Storage Sensors.

Instructions

Increment 1: Determine the Objective

- Determine the objective and perform System and Software Requirement Analysis.
- Describe expected software features, constraints, interfaces, and attributes.
- Prepare Software Requirements Specifications (SRS) for agreed requirements, serving as the basis for design and system testing.

Increment 2: Design the application

- Provide a detailed description of how the software will fulfill the specified requirements, including the rationale for design decisions made.
- Develop a comprehensive design document that encompasses database design, UI design, data definition, and manifest file, as applicable to the project.
- Create a Software Design Description (SDD) outlining the design and associated decisions, serving as the foundation for implementation and unit testing. Include plans and specifications for software verification and validation.
- Generate Software Test Documentation (STD) to detail the testing procedures, methodologies, and record the outcomes of the software testing process.

Increment 3: Develop and refine the application

- Create the application using selected languages, databases, and platforms.
- Test the application based on the provided test document.
- Demonstrate the application.

Guidelines for evaluation:		***Marks***
1. Regularity and progress of work		5
2. Work knowledge and Involvement		5
3. Semester End presentation and assesment		20
4. Level of completion and demonstration of Functionality / Specifications		10
5. Project Report – Presentation style and content		10
	Total	**50**

References:

1. Hohensee, B., & Dharma, A. (2014). Android for beginners: Developing apps using Android Studio. Babelcube Inc.
2. Smyth, N. (2020). Android Studio 4.0 Development Essentials - Java Edition: Developing Android Apps Using Android Studio 4.0, Java and Android Jetpack.
3. Bailey, T., & Biessek, A. (2021). Flutter for Beginners - Second Edition: An Introductory Guide to Building Cross-platform Mobile Applications with Flutter 2.5 and Dart. Packt Publishing.
4. Iversen, J., & Eierman, M. (2014). Learning mobile app development: A hands-on guide to building apps with iOS and Android. Addison-Wesley.
5. Smyth, N. (2019). Android studio 3.2 development essentials - Android 9 edition. Payload Media.
6. Napoli, M. L. (2019). Beginning flutter: A hands on guide to app development. John Wiley & Sons.

SEMESTER VII

23-204-0701 FINANCIAL MANAGEMENT AND E-BANKING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand accounting fundamentals, bookkeeping, double-entry, journal/ledger, final accounts preparation.
2. Comprehend cost accounting, cost classification, costing methods, marginal costing, break-even analysis.
3. Analyse funds flow statements, working capital changes, funds from operations.
4. Explore e-banking, home banking, online banking approaches, security, management issues.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3		1			2					1	2			2
CO2	2	3	3	2			2					1	2	2		2
CO3	2	2	3	1			2				2	1	2			2
CO4	1	2		2			3				1	1	2	2	2	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

The basic Accounting concepts, Accounting terms, Book keeping, difference between Book keeping and accounting Double entry system, Preparation of Journal entries, thorough American Approach (modern Approach), Preparation of Ledger Accounts, Balancing of Ledger Accounts. Preparation of Final Accounts, Trading, Profit and Cost Accounts and Balance sheet. Adjustments in Final Accounts regarding outstanding expenses, Depreciation, Prepaid expenses, accrued incomes, Treatment of Bad debts and provision for Bad debts, Closing stock etc.

Module II

Cost Accounting, Concepts, meaning, Classification of Cost, Preparation of Cost sheet, Material Pricing: LIFO, FIFO, Marginal Costing and Break-Even Analysis

Module III

Funds Flow Statement–Meaning, importance, Definition of Funds and Flow, Sources and uses of Funds, Schedule of changes in Working Capital, Funds from operation and its calculation, preparation of Funds flow statement.

Module IV

E-banking changing Dynamics in banking industry Home Banking meaning, Home Banking implementation, Approaches, Banking via PC using Dial up Software, Banking via online services, Banking via the web: Security First Network Bank. Management issues in online banking, Pricing issues in online banking, Marketing issues in online banking.

References:

1. Weygandt, J. J., Kimmel, P. D., & Kieso, D. E. (2022). Financial accounting (12th ed.). Wiley.
2. Laudon, K. C., & Traver, C. G. (2023). E-commerce 2023: Business, technology and society (17th ed.). Pearson.
3. Subramanyam, K. R., & Wild, J. J. (2019). Financial statement analysis (12th ed.). McGraw-Hill Education.
4. Dhameja, N., Sastry, K., & Dhameja, K. (2014). Finance and accounting for managerial competitiveness (Revised and enlarged ed.). S. Chand & Company.
5. Brigham, E. F., & Houston, J. F. (2004). Fundamentals of financial management (10th ed.). Thomson/South-Western.
6. Kalakota, R., & Whinston, A. B. (1997). Electronic commerce: A manager's guide. Addison-Wesley.
7. Khan, M. Y., & Jain, P. K. (2000). Theory and problems in financial management (2nd ed.). Tata McGraw-Hill.

23-204 -0702 DESIGN THINKING AND INNOVATIONS

Course Outcomes:

On completion of this course the student will be able to:

1. Develop a thorough, hands on understanding of the design thinking innovation and experimentation approach.
2. Understand how design integrates with strategy, architecture and agile to develop a complementary learn fast and scale fast set of toolkits and skills that can be used in any part of the organization
3. Apply Design Thinking techniques when starting a new product or service
4. Identify the Design Thinking stages: Comprehension, Ideation, Prototyping, Evaluation

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2						3		3		3	2		2
CO2	2	2	3	3						3	3		3	2		
CO3	1	3	3		3						3		3	2		2
CO4	1	3	2		3		3						3	2		

1-Slightly**; 2**-Moderately**; 3-**Substantially

Module I

Overall approach to Design Thinking: Definitions of Design Thinking, "Design" in Design Thinking, The 3 phases of Design Thinking.

Module II

Data Collection: Introduction to “How Might We?” question, The challenge definition and its scope, Type of data, Value Analysis, Qualitative and primary data collection.

Module III

Data Analysis: Formatting the data: Journey mapping and personas, Insight Emergence, Synthesis of the inspiration phase, Design personae, Examples of Personae and Journey maps, Identify extreme users, Criteria for insights.

Module IV

Ideation: Ideas generation, rules for ideas generation, tips for ideas generation and fixation effect. Implementation: Assumptions Identification, Principles for prototyping. Organizational setting for Design Thinking: Diffusion of Design Thinking, Diffusion of Design Thinking, A
cognitive explanation, Diffusion of Design Thinking, A team perspective, How Design Thinking is adopted in firms, Where Design Thinking is hosted within firms, Performance indicators, Key Success Factor.

References:

1. Cross, N. (2011). Design thinking: Understanding how designers think and work. Bloomsbury Academic
2. Brown, T., & Katz, B. (2019). Change by design: How design thinking transforms organizations and inspires innovation HarperBusiness..
3. Liedtka, J. (2018). Why design thinking works. Harvard Business Review, 96(5), 72-79.
4. Lockwood, T. (2009). Design thinking: Integrating innovation, customer experience, and brand value. Allworth Press.
5. Martin, R. L. (2009). The design of business: Why design thinking is the next competitive advantage. Harvard Business Review Press.

23-204-0703 COMPUTER GRAPHICS AND VISUAL COMPUTING

Course Outcomes:

On completion of this course the student will be able to:

1. Describe the fundamental principles that underlie the computer graphics algorithm.
2. Implement two dimensional graphical structures.
3. Design and develop three dimensional graphical structures.
4. Comprehend computer animation.
5. Build graphics programs using OpenGL

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2							1	3	2		
CO2	2	2	3	2	3							1	3	3		
CO3	2	2	3	2	3							1	3	3		
CO4	2	2	2	2	2							1	3	2		
CO5	2	2	3	2	3							1	3	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Overview of graphic systems: Video Display devices, Raster Scan Systems, output primitives, Applications of computer graphics.

Algorithms for Graphics primitives and attributes: Points and Lines, Line drawing algorithms, Circle generation algorithms, Ellipse generating algorithms, Scan Line Fill, Fill methods for areas with irregular boundaries.

Introduction to OpenGL

Module II

Two dimensional Geometric transformations: Basic Transformations, Matrix representations and homogeneous coordinates, Reflection, Shear, Composite transformations, Raster methods for transformations, 2D transformation functions.

2D Viewing Pipeline, viewing coordinate reference frame, Window to viewport transformation, 2D viewing functions.

Clipping: Point Clipping, Line Clipping, Polygon clipping, Text clipping.

Module III

Three dimensional transformations: Translation, Rotation, Scaling, 3D transformation functions. Three-dimensional viewing concepts.

Polygon Surfaces - Polygon tables, Spline Representations- Interpolation and approximation splines, convex hull, control polygon, continuity conditions, Bezier curves and surfaces, B spline curves and surfaces.

Sweep representations, Constructive Solid Geometry methods, octrees, BSP trees.

Module IV

Fractal Geometry methods, Visible surface detection algorithms: classification, Back face detection, Depth buffer method, A buffer method, Scan line method, Depth sorting method, BSP tree method, Area subdivision method, Wireframe methods. Computer Animation

Graphics Card: Processing on the Graphics card, Graphics Pipeline, NVIDIA CUDA Libraries.

References:

1. Hearn, D., & Baker, M. P. (2011). Computer graphics with OpenGL (4th ed.). Pearson Education
2. Marschner, S., & Shirley, P. (2021). Fundamentals of computer graphics (5th ed.). CRC Press.
3. Akenine-Möller, T., Haines, E., & Hoffman, N. (2019). Real-time rendering (4th ed.). A K Peters/CRC Press.
4. Hughes, J. F., van Dam, A., McGuire, M., Sklar, D. F., Foley, J. D., Feiner, S. K., & Akeley, K. (2013). Computer graphics: Principles and practice (3rd ed.). Addison-Wesley.
5. Foley, J. D., van Dam, A., Feiner, S. K., Hughes, J. F., & Phillips, R. L. (1994). Introduction to computer graphics. Addison-Wesley.
6. Hill Jr, F. S., & Kelley, S. M. (2007). Computer graphics using OpenGL (3rd ed.). Pearson/Prentice Hall.
7. Duane, S., & Mete, Y. (2016). CUDA for engineers: An introduction to high-performance parallel computing. Addison-Wesley.

PROFESSIONAL ELECTIVE – III

23-204-0704 INDUSTRIAL MANAGEMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the concept of Industry 5.0 and its focus on human-machine collaboration, recognize central features, recall differences from previous industrial revolutions, and define upskilling, reskilling, resource efficiency, and mass customization.
2. Explain Industry 5.0 drivers, describe trends shaping the landscape, understand the significance of lifelong learning, and discuss the need for technological adaptation.
3. Evaluate human-machine collaboration, apply effective leadership styles, design products for longevity, repairability, and recyclability, utilize data analytics for personalization, and ensure fairness in AI systems.
4. Evaluate the balance between profit, people, and planet in business decisions and Map the customer journey using data insights.
5. Propose ways to use AI for societal well-being while maintaining security and social responsibility.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3										3			3
CO2	3	2					3					3	2	2		
CO3	2	2	2	3					3					2		
CO4	1	2		2			3	3								
CO5	1	1			2	3					3			2		3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Industry 5.0: Defining Industry 5.0 and its key features, Comparing Industry 5.0 with previous industrial revolutions, Drivers and trends shaping the Industry 5.0 landscape.

Human-Machine Collaboration -Collaborative robots (cobots) and their impact on productivity, Leadership styles for effective human-machine teamwork.

Module II

Workforce Transformation and Skills Development-Upskilling and reskilling initiatives for the Industry 5.0 workforce, Attracting and retaining talent with new skills and competencies, Lifelong learning in the Industry 5.0 context, Adapting to technological advancements.

Module III

Sustainable Business Practices- Resource Efficiency and Green Supply Chain, Optimizing resource utilization, Designing environmentally responsible supply chains. Circular Economy Strategies- Product design for longevity, repairability, and recyclability. Triple Bottom Line Approach - Balancing profit, people, and planet. Case studies of circular economy implementation (industry specific).

Module IV

Customization and Personalization - Mass Customization, Technology-enabled customized products. Data-Driven Decision-Making - Personalization through data analytics, Customer journey mapping.

Ethics and Responsible AI -AI enhancing human decision-making, Explainable AI and transparency. AI Bias and Fairness, Ensuring fairness in AI systems, Privacy, Security, and Social Responsibility, Using AI for societal well-being.

References:

1. Elangovan, U. (2021). Industry 5.0: The future of industry economy. CRC Press. https://doi.org/10.1201/9781003086336
2. Leong, W. Y. (Ed.). (2021). Human machine collaboration and interaction for smart manufacturing. Institution of Engineering and Technology. https://doi.org/10.1049/PBCE132E
3. Hitchcock, D., & Willard, M. (2009). The business guide to sustainability: Practical strategies and tools for

organizations (2nd ed.). Routledge. https://doi.org/10.4324/9781849774551
4. Lacy, P., Long, J., & Spindler, W. (2020). The circular economy handbook: Realizing the circular advantage. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-58119-7
5. Pine, B. J. (1993). Mass customization: The new frontier in business competition. Harvard Business Review Press.
6. Davenport, T. H., & Harris, J. G. (2017). Competing on analytics: Updated, with a new introduction: The new science of winning. Harvard Business Review Press.
7. Naidu, Y. (2019). Story mastery: How leaders supercharge results with business storytelling. Yamini Naidu.
8. Pasquale, F. (2015). The black box society: The secret algorithms that control money and information. Harvard University Press.

23-204-0705 GENERATIVE AI

Course Outcomes:

On completion of this course the student will be able to:

1. Understand generative modeling fundamentals for engineering applications.
2. Proficient in basic generative models for effective data modeling.
3. Deep understanding of advanced generative models and their engineering applications.
4. Explore GAN architectures and training techniques.
5. Apply generative models to various engineering tasks for innovative solutions.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2											3	1		
CO2	2	3	1	2									2			
CO3	1	1	3	2									2	1		
CO4	2	2		3									1			
CO5	1	2	3	3	3		2						1	1		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Generative Models: Overview of generative modeling approaches, Applications in engineering domains like CAD, digital Twin.

Basic Generative Models: Probabilistic modeling and inference, Linear models like PCA, Mixture models and EM algorithm.

Module II

Deep Generative Models: Denoising Autoencoders, Adversarial Autoencoders, Normalizing Flow Models (e.g., Real NVP, Glow), Variational autoencoders, Generative adversarial networks. Advanced Generative Modeling: Energy based models, Transformers for generative modeling, Autoregressive models with attention (e.g., Transformer-XL, Image GPT), Diffusion Models (e.g., DDPM, Stable Diffusion), Score-based Generative Models

Module III

GAN Architectures and Algorithms: Deep Convolutional GANs (DCGANs) -Architecture and Training - Wasserstein GANs (WGANs) - Improving GAN Stability and Training - Conditional GANs (CGANs) - Incorporating Class Information. StyleGAN and StyleGAN2, BigGAN and BigGAN-deep, Self-Attention GANs (SAGAN),Cycle-Consistent GANs (CycleGAN)

Module IV

Generative Models for Engineering: Computer vision for inspection and quality control, Simulation and digital twin using generative models, Anomaly detection in predictive maintenance, Drug discovery and molecular generation. Synthetic data generation for data augmentation, Text generation and language modeling, Music and audio generation Video generation and prediction, Generative adversarial imitation learning

References:

1. Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., ... & Bengio, Y. (2014). Generative adversarial nets. Advances in neural information processing systems, 27.
2. Creswell, A., White, T., Dumoulin, V., Arulkumaran, K., Sengupta, B., & Bharath, A. A. (2018). Generative adversarial networks: An overview. IEEE Signal Processing Magazine, 35(1), 53-65.
3. Kingma, D. P., & Welling, M. (2013). Auto-encoding variational bayes. arXiv preprint arXiv:1312.6114.
4. Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., ... & Bengio, Y. (2014). Generative adversarial nets. Advances in neural information processing systems, 27.
5. Du, Y., & Mordatch, I. (2019). Implicit generation and generalization in energy-based models. Advances in Neural Information Processing Systems, 32.
6. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. Advances in neural information processing systems, 30.

7. Yi, X., Walia, E., & Babyn, P. (2019). Generative adversarial network in medical imaging: A review. Medical image analysis, 58, 101552.
8. Lee, J., Shin, J., & Realff, M. J. (2020). A GAN-based anomaly detection method for accident identification in nuclear power plants. Nuclear Engineering and Technology, 52(6), 1326-1336.
9. Linderman, G. C., Rachh, M., Hoskins, J. G., Steinerberger, S., & Kluger, Y. (2019). Fast interpolation-based t-SNE for improved visualization of single-cell RNA-seq data. Nature methods, 16(3), 243-245.

23-204-0706 QUANTUM COMPUTING

Course Outcomes:

On completion of this course the student will be able to:

1. Grasp the fundamental principles of quantum computation, including Quantum Mechanics and the Circuit Model of Computation.
2. Apply matrix algebra concepts in the context of quantum computing, covering basis vectors, orthogonality, and unitary operators.
3. Comprehend key quantumness principles, such as the no-cloning theorem, quantum entanglement, and the functionality of various quantum gates.
4. Utilize quantum algorithms, including the Deutsch Algorithm, Simon's Algorithm, and Grover's Quantum Search Algorithm.
5. Acquire knowledge in quantum information, encompassing Quantum Error Correction and Quantum Cryptography.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1		3	3					1	1	3	3	3	3
CO2	3	3	3		3						1	1	3	3	3	3
CO3	1	2	1			3							1		3	3
CO4	1	2	1		3						1	1	1	3		3
CO5	3	2	1		3						1	1	1			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Quantum Computing: Quantum Mechanics, Church–Turing Thesis, The Circuit Model of Computation, A Linear Algebra Formulation of the Circuit Model, Reversible Computation. Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation,

Module II

Quantum Computation: Fundamentals of Quantumness, no cloning theorem, quantum entanglement, Bell states and Bell inequalities. Quantum Circuits, Pauli, Hadamard, phase,
CNOT, Toffoli gates quantum teleportation universality of two qubit gates reversible computing

Module III

Quantum Algorithms: Probabilistic Versus Quantum Algorithms, Phase Kick Back, The Deutsch Algorithm, The Deutsch–Jozsa Algorithm, Simon's Algorithm, Quantum Phase Estimation and the Quantum Fourier Transform, Grover's Quantum Search Algorithm, Shor's period finding algorithm

Module IV

Quantum Information: Quantum, Error Correction, Shannon Entropy, Von Neuman Entropy, Classical Cryptography, RSA Algorithm, Quantum Cryptography, BB 84 protocol, B 92 and Eckart protocol.

References:

1. Kaye, P., Laflamme, R., & Mosca, M. (2007). An introduction to quantum computing. Oxford university press.
2. Bernhardt, C. (2019). Quantum Computing for Everyone (MIT Press).
3. Robinson, T. R. (2023). The Quantum Nature of Things: How Counting Leads to the Quantum World. Copyright 2023.
4. Nielsen, M. A., & Chuang, I. (2010). Quantum computation and quantum information. Cambridge university press.
5. Yanofsky, N. S., & Mannucci, M. A. (2008). Quantum computing for computer scientists. Cambridge University Press. https://doi.org/10.1017/CBO9780511800589
6. McMahon, D. (2008). Quantum computing explained. John Wiley & Sons.
7. Mermin, N. D. (2007). Quantum computer science: an introduction. Cambridge University Press.

23-204-0707 PROMPT ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand Prompt Engineering Principles including precision of prompts, ethical considerations, and impact on system performance etc.
2. Design Effective Prompts for NLP Tasks including text generation, question answering, sentiment analysis etc.
3. Evaluate and Refine Prompts for HCI through conversational agents and user interfaces.
4. Apply Advanced Techniques in Prompt Engineering including Transfer learning, multimodal prompts

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3				3		3						2			
CO2	3	1	3	2		3							2			
CO3		3	1	3		3							2			
CO4	3		3	1				3					2			
CO5	3				3		3						2			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Prompt Engineering: Definition and significance of prompt engineering, Historical context and evolution. Foundations of Machine Learning and Language Models: Overview of machine learning techniques. Introduction to language models, Connection between prompts and model outputs. Benefits of ChatGPT and Large Language Models, Limitations of Large Language Models and ChatGPT

Module II

Prompt Design Principles. Crafting effective prompts for different tasks, Understanding context and specificity, Ethical considerations in prompt design, Ambiguity reduction in formulating prompts, Constraint-based prompting to specific tasks

Module III

Prompt Engineering in Natural Language Processing. Text generation with prompts, Information retrieval and question-answering, Sentiment analysis and language understanding, Prompt response evaluation techniques, Six specific dimensions of response quality: Relevance, Accuracy, Completeness, Clarity, Coherence and Appropriateness (the RACCCA framework)

Module IV

Human-Computer Interaction and Prompt Engineering. Designing prompts for user interfaces, Conversational agents and chatbot prompts, User feedback and iterative prompt refinement, Chain-of-Thought (CoT) Approach in Prompt Engineering, Transfer learning and pre-trained models, Multimodal prompt engineering
Case Study: Designing and evaluating a prompt for a specific task.

References:

1. Lane, H. C., Howard, N., & Hapke, M. (2019). Natural language processing in action: Understanding, analyzing and generating text with python. Manning Publications.
2. Martin, J. H., & Jurafsky, D. (2008). Speech and language processing (2nd ed.). Prentice Hall.
3. Zhang, A., Ramesh, R., Lee, Y., & Wang, X. (2021). Overview of machine learning and language model techniques. Proceedings of the 2021 4th International Conference on Artificial Intelligence and Big Data, 125-130. https://doi.org/10.1145/3487552.3494473
4. Harris, S. (2020). Crafting ethical prompts for safety-critical applications. Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society, 55–61. https://doi.org/10.1145/3375627.3375835
5. Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2018). Bert: Pre-training of deep bidirectional transformers for language understanding. arXiv preprint arXiv:1810.04805.

OPEN ELECTIVE – I

23-204-0708 EDUCATION TECHNOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. State the role of ET in the teaching-learning process.
2. Differentiate various Learning Theories, Learning Styles and Cognitive Processes.
3. Categorize the educational objectives in 3 domains.
4. Apply various ET tools for content creation, content delivery, and assessment.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1				2							3	2			
CO2	3												2			
CO3	3												2			
CO4	2		2		3								3			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Educational Technology: What is ET, domains of ET, media literacy, information literacy. Technology in the classroom: selection of media (audio, video, multimedia, animations and simulations), SAMR model of technology integration, Technologies for creating new resources. Technology-enhanced lessons: teachers vs students use of technology in the classroom. Teaching and Learning with Technology in Special Education.

Module II

Learning theories - constructivism, cognitivism, behaviorism; Factors affecting and facilitating learning; Different Cognitive Processes. Learning Styles. Felder–Silverman Learning Style Model (FSLSM). Learning objectives and Bloom's taxonomy; affective, cognitive, and psychomotor domains. Integrating Technology with Bloom's Taxonomy: Digital Bloom's Taxonomy. Instructional Design (ID): ID models (eg. ADDIE model, Dick and Carey model), Online course development using ID.

Module III

Assessment Vs Measurement. Types of Assessment: Diagnostic, Formative, Summative. Reliability and validity of assessment. Tools for digital assessment: spreadsheets and databases, Quizlet, Kahoot, optical scanning using a smartphone or tablet, Hot Potatoes. Content Authoring Tools: Eg. Raptivity, Articulate.
Content Management Systems (e.g. Joomla, Drupal)

Module IV

Issues related to Education Technology: Access, safety and copyright, ethical and legal issues. Use of digital videos and movies in class. Learning Management Systems (e.g. Moodle, Sakai LMS, Schoology, Google Classroom), Open Education Resources, Intelligent Tutoring Systems.

References:

1. Fishman, B., & Dede, C. (2016). Teaching and technology: New tools for new times. In D. Gitomer & C. Bell , Handbook of research on teaching (5th ed.). American Educational Research Association.
2. Hergenhahn, B. R., & Olson, M. H. (2001). An introduction to theories of learning (7th ed.). Prentice Hall.
3. M. D. Roblyer and Aaron H. Doering. (2014) Integrating Educational Technology into Teaching. Pearson Edition: 8th Edition (or the latest edition available).
4. Anderson, Lorin W., Krathwohl, David R., Airasian, Peter W. (2000). A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives, Second Edition. Pearson.
5. Renumol, V. G., Janakiram, D., & Jayaprakash, S. (2010). Identification of cognitive processes of effective and ineffective students during computer programming. ACM Transactions on Computing Education (TOCE).
6. Open University Innovation Reports: Innovating pedagogy Reports (2012 to 2023). (http://www.open.ac.uk/blogs/innovating/)
7. Cult of Pedagogy. (2018). Teacher's Guide to Tech 2018. Retrieved from https://cultofpedagogy.teachable.com/p/teachersguidetotech2018
8. University of Victoria. Hot Potatoes. Retrieved from https://hotpot.uvic.ca/
9. Arizona State University. (2016). Integrating Technology: Bloom's Taxonomy. Retrieved from https://teachonline.asu.edu/2016/05/integrating-technology-blooms-taxonomy

23-204-0709 GAME DESIGN

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental principles of game design and proficiency in using game development tools and technologies.
2. Create comprehensive game design documents and prototypes and apply storytelling techniques to enhance the narrative in games
3. Design and implement core game mechanics and dynamics and develop user-friendly interfaces and ensure a positive user experience.
4. Understand the complexities of multiplayer and online game design and apply game design principles to serious games and gamification.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2										2	2	1		
CO2	3	2	1	1								1	1	2		
CO3	2	2	2	1	1							1	2	1		
CO4	2	2	1									1	2	1		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Game Design: Overview of game design principles, Historical perspective of game design, Importance of user experience in games. Game Development Tools and Technologies: Introduction to game engines (e.g., Unity, UNreal Engine), Basics of 3D modeling and animation, Programming basics for game development.

Module II

Game Design Documents and Prototyping: Creating game design documents, Rapid prototyping techniques, Playtesting and feedback. Storytelling in Games: Narrative structure in games, Character development and story arcs, Interactive storytelling techniques.

Module III

Game Mechanics and Dynamics: Core game mechanics, Balancing and tuning game systems, player engagement and motivation. User Interface (UI) and User Experience (UX) Design: Designing intuitive user interfaces, player-centered design principles, Usability testing in games.

Module IV

Multiplayer and Online Game Design: Fundamentals of multiplayer game design, Networking and server-client architecture, social aspects of online gaming. Serious Games and Gamification: Applications of games in education and training, Designing games for behavioral change, Gamification principles.

References:

1. Schell, J. (2019). The Art of Game Design (3rd ed.). A K Peters/CRC Press.
2. Gazaway, D. (2021). Introduction to Game Systems Design. Addison-Wesley Professional.
3. Sellers, M. (2017). Advanced Game Design. Addison-Wesley Professional.
4. Salen, K., & Zimmerman, E. (2003). Rules of play: Game design fundamentals. MIT press.
5. Schell, J. (2014). The Art of Game Design: A book of lenses (2nd ed.). AK Peters/CRC Press.
6. Rogers, S. (2014). Level up! The guide to great video game design (2nd ed.). John Wiley & Sons.
7. Fullerton, T. (2014). Game design workshop: A playcentric approach to creating innovative games (3rd ed.). AK Peters/CRC Press.
8. Hocking, J. (2019). Unity in action: Multiplatform game development in C#. Manning Publications.
9. Swink, S. (2009). Game feel: A game designer's guide to virtual sensation. CRC Press.

23-204-0710 MULTIMEDIA COMPUTING

Course Outcomes:

On completion of this course the student will be able to:

1. Familiarize with the common computing fundamentals employed in a variety of multimedia applications.
2. Analyse different compression principles, different compression techniques, different multimedia compression standard.
3. Learn the characteristics of multimedia database and how to manage it.
4. Design and develop multimedia systems according to the requirements of multimedia applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3										3	1		
CO2	3	2	3	3									3		1	2
CO3	3	3	2		3	3							3	1		
CO4	1	3	2	2			3	3					3	1		1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Multimedia media and Data streams properties of a multimedia system, Data streams characteristics information units, Multimedia Hardware platforms Memory and storage devices, Input and output devices, Multimedia software tools.

Module II

Multimedia Building blocks Audio: Basic sound concepts, Music speech audio file formats, Images and graphics: Basic concepts, computer image processing, Video and Animation: Basic concepts, Animation techniques.

Module III

Data compression: Storage space and coding requirements, source entropy and Hybrid coding Basic compression techniques, JPEG, H.261, MPEG, DVI, Multimedia Database systems, Characteristics of Multimedia Database Management system, data analysis, Data structure operations on data, Integration in a database Model.

Module IV

Multimedia Documents, Hypertext and Hypermedia document architecture, SGML, Document architecture, ODA, MHEG. Multimedia applications: Introduction Media, Preparation Media, composition Media, Integration Media, communication Media, consumption Media entertainment trends.

References:

1. Sayood, K. (2017). Introduction to data compression (5th ed.). Morgan Kaufmann.
2. Steinmetz, R., & Nahrstedt, K. (2009). Multimedia: Computing, communications & applications. Prentice Hall.
3. Parekh, R. (2006). Principles of multimedia. Tata McGraw-Hill Education.
4. Buford, J. F. (2007). Multimedia systems. ACM Press
5. Vaughan, T. (2010). Multimedia: Making it work (8th ed.). McGraw-Hill.

23-204-0711 WEB MINING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals and scope of web mining.
2. Develop skills in web crawling, data preprocessing, and cleaning. Students will be able to apply various web mining techniques to extract information from web content and structure.
3. Understand the ethical and legal considerations in web mining.
4. Apply web mining techniques to real-world scenarios through hands-on projects.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2										2	2	1		
CO2	3	2	1	1								2	2	3		
CO3	2	2	3	1	1	1						1	2	1	1	
CO4	2	2	3	3	1	1						1	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Web Mining: Overview of Data Mining and its applications, Definition, scope and significance, Types of Web Mining: Web Content Mining, Web Structure Mining, Web Usage Mining, Applications of Web Mining in various domains.

Module II

Information Retrieval systems, Web Crawling and Indexing: Basics of web search engines, Document Representation and Preprocessing. Web content Mining: Text mining techniques for extracting information from web content. Natural Language Processing (NLP) for web content analysis. Case studies and practical examples.

Module III

Web structure Mining: Introduction to the structure of the web (HTML, XML). Link Analysis algorithms: PageRank, HITS. Social Network Analysis (SNA) in the context of web structure mining. Web Usage Mining: Understanding user behavior on the web, Data preprocessing for web usage for web mining. Association rule mining for discovering patterns in user behavior.

Module IV

Privacy and Ethical issues in Web Mining: Privacy Concerns in web mining, Ethical considerations and responsible use of web mining techniques, Legal aspects and regulations related to web mining. Introduction to web mining tools and software, Practical sessions using popular tools (e.g., BeautifulSoup, Scrapy, RapidMiner). Hands-on exercises and projects.

Case studies and Projects for assignments: Real-world applications of web mining in various industries. Group projects where students apply web mining techniques to solve a practical problem. Presentation and discussion of project outcomes.

References:

1. Han, J., Pei, J., Kamber, M., Pham, Q. V., & Deng, A. (2023). Data mining: Concepts and techniques (4th ed.). Morgan Kaufmann Publishers, An imprint of Elsevier.
2. Markov, Z., & Larose, D. T. (2022). Data mining the web: Uncovering patterns in web content, structure, and usage. Wiley.
3. Scime, A. (2005). Web mining: Applications and techniques. IGI Global. https://doi.org/10.4018/978-1-59140-343-9
4. Chakrabarti, S. (2002). Mining the Web: Discovering knowledge from hypertext data. Morgan Kaufmann.
5. Schütze, H., Manning, C. D., & Raghavan, P. (2008). Introduction to information retrieval. Cambridge University Press. https://doi.org/10.1017/CBO9780511809071
6. Han, J., & Kamber, M. (2006). Data mining: Concepts and techniques (2nd ed.). Morgan Kaufmann.
7. Liu, B. (2011). Web data mining: Exploring hyperlinks, contents, and usage data. Springer Science & Business Media. https://doi.org/10.1007/978-3-642-19460-3

23-204-0712 COMPUTER GRAPHICS LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Develop programs to implement different drawing algorithms using OpenGL.
2. Develop programs to implement image manipulation and enhancement.
3. Create 3D graphical animation scenes using open graphics library suites.
4. Demonstrate parallelization using GPU.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3	2	3				1	2		1	3	3		
CO2	2	2	3	2	3				1	2		1	3	3		
CO3	2	2	3	2	3				1	2		1	3	3		
CO4	2	2	3	2	3				1	2		1	3	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A: Implement the exercises using C/ OpenGL/ Java

1. Implementation of algorithms for drawing 2D primitives.
    a. Line (DDA, Bresenham) all slopes.
    b. Circle (Midpoint)
2. 2D Geometric transformations
    a. Translation
    b. Rotation
    c. Scaling
    d. Reflection
    e. Shear
    f. Window Viewport
3. Clipping

Part B: Implement the exercises using OpenGL

1. 3D Transformations: Translation, Rotation, Scaling.
2. 3D Projections: Parallel, Perspective
3. Creating 3D Scenes
4. 2D Animation to create interactive animation using any authoring tool

Part C: Parallelization using GPU

Demonstrate the implementation of parallelization using GPU to accelerate a specific computational task in the lab and study how optimizations can be applied to enhance its performance

References:

1. Hearn, D., & Baker, M. P. (2011). Computer graphics with OpenGL (4th ed.). Pearson Education.
2. Marschner, S., & Shirley, P. (2021). Fundamentals of computer graphics (5th ed.). CRC Press.
3. Akenine-Möller, T., Haines, E., & Hoffman, N. (2019). Real-time rendering (4th ed.). A K Peters/CRC Press.
4. Hughes, J. F., van Dam, A., McGuire, M., Sklar, D. F., Foley, J. D., Feiner, S. K., & Akeley, K. (2013). Computer graphics: Principles and practice (3rd ed.). Addison-Wesley.
5. Hill Jr, F. S., & Kelley, S. M. (2007). Computer graphics: Using OpenGL (3rd ed.). Pearson/Prentice Hall.
6. Duane, S., & Mete, Y. (2016). CUDA for engineers: An introduction to high-performance parallel computing. Addison-Wesley.

23-204 -0713 MINI PROJECT – MULTIMEDIA PROJECT

Course Outcomes:

On completion of this course the student will be able to:

1. Utilize industry tools for animation, VFX, and video production.
2. Apply techniques like motion capture, keying, and particle systems.
3. Integrate audio/video capturing and synchronization workflows.
4. Collaborate effectively in a professional team environment.
5. Prepare detailed report covering designs, diagrams, explanations, tools, challenges, and testing.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	3	3					1		1	3	3		1
CO2	2	3	3	3	3				1	1		1	3	3	1	
CO3	2	3	3	3	3				1	2		1	3	3		
CO4		1	1						3	2	1	1	3	3		2
CO5	2	1	2	1	1				1	2		1	3	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A

Projects can be done using softwares like Blender with Python scripting, OpenCV, Kinect, OpenGL, DirectX, Unity etc.

The projects can be of any of the following type.

- Development of Augmented Reality in the areas like education, marketing, advertisement in magazines, movies, astronomy, map, navigator, 3D games, weather condition, Healthcare etc.
- Development of Virtual Reality in the areas like Military, Education, Healthcare, Entertainment, Fashion, Business, Scientific visualization, Construction, Film, Telecommunication etc.
- Motion Capturing in Interactive Graphics
- Lossless and Lossy Media Encoding and Compression
- Development of media player in multimedia framework like gstreamer, ffmpeg etc
- Creating interactive computer games.
- Real Time communication using media and IP streaming

Part B

Students shall develop an application making use of minimum of three services from the following list:
Multimedia Animations, Audio Capture, Audio Manager, Camera, Image Effects, Image Switcher, Media Player, Jet Player, Networking Bluetooth, Network Connection, SIP Protocol, WiFi, Social Services Facebook Integration, Google Maps LinkedIn Integration, Twitter Integration, User Interface Auto Complete, Multitouch, Clipboard, Custom Fonts, Gestures, UI Design, UI Patterns, UI Testing, Database, PHP/MySQL, Data Backup, SQLite Database, Internal Storage Sensors.

Instructions

Increment 1: Determine the Objective

- Determine the objective and perform System and Software Requirement Analysis.
- Describe expected software features, constraints, interfaces, and attributes.
- Prepare Software Requirements Specifications (SRS) for agreed requirements, serving as the basis for design and system testing.

Increment 2: Design the application

- Provide a detailed description of how the software will fulfill the specified requirements, including the rationale for design decisions made.
- Develop a comprehensive design document that encompasses database design, UI design, data definition, and manifest file, as applicable to the project.
- Create a Software Design Description (SDD) outlining the design and associated decisions, serving as the foundation for implementation and unit testing. Include plans and specifications for software verification and

validation.

- Generate Software Test Documentation (STD) to detail the testing procedures, methodologies, and record the outcomes of the software testing process.

Increment 3: Develop and refine the application

- Create the application using selected languages, databases, and platforms.
- Test the application based on the provided test document.
- Demonstrate the application.

Guidelines for evaluation:		***Marks***
1. Regularity and progress of work		5
2. Work knowledge and Involvement		5
3. Semester End presentation and assesment		20
4. Level of completion and demonstration of Functionality / Specifications		10
5. Project Report – Presentation style and content		10
	Total	**50**

References:

1. Biswas, R. (2023). Learn Unity Game Development - Build Six Games with Unity 2023. Packt Publishing.
2. Buttfield-Addison, P., Manning, J., & Nugent, T. (2023). Unity Development Cookbook, 2nd Edition. O'Reilly Media, Inc.
3. Bekhit, A. F. (2021). Computer Vision and Augmented Reality in iOS: OpenCV and ARKit Applications. Apress.
4. Aukstakalnis, S. (2016). Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR. Addison-Wesley Professional.
5. Richardson, I. E. (2003). H. 264 and MPEG-4 video compression: Video coding for next-generation multimedia. John Wiley & Sons.
6. Thorn, A. (2013). Game engine design and implementation. Jones & Bartlett Learning

23-204-0714 ENTREPRENEURSHIP DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Develop awareness about the importance of entrepreneurship opportunities available in the society
2. Get acquainted with the challenges faced by the entrepreneur

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1			1		1		1	3	3	1	1
CO2	3	3	3	3	1			1		1		1	3	3	1	1

1-Slightly**; 2**-Moderately**; 3-**Substantially

Exercises

1. To study the types of entrepreneurs and the factors affecting entrepreneurial growth.
2. To make an assessment of the major motives influencing an entrepreneur
3. To make an overview of the various stress management techniques
4. How to identify and select a good business opportunity?
5. Preparation of a techno economic feasibility report for a given project
6. Preparation of a preliminary project report for a given project
7. To identify the various sources of finance and management of working capital
8. Carry out the costing and break-even analysis of a proposed project
9. Preparation of a PERT / CPM chart for the various activities involved in a project
10. To make a study of the various causes and consequences of sickness in small business and identify corrective measures.
11. To analyze logistics and supply chain processes for a proposed business venture

References:

1. Roy, R. (2011). Entrepreneurship (2nd ed.). Oxford University Press.
2. Baron, R. A. (2018). Entrepreneurship: A Process Perspective (3rd ed.). Cengage Learning
3. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017). Entrepreneurship (10th ed.). McGraw-Hill Education.
4. Gordon, E., & Natarajan, K. (2009). Entrepreneurship development. Himalaya Publishing House.
5. Coulter, M. K. (2001). Entrepreneurship in action (2nd ed.). Prentice Hall.
6. Jain, P. S. (1998). Handbook for new entrepreneurs. Oxford University Press.
7. Khanka, S. S. (2010). Entrepreneurial development. S. Chand Publishing.

Note: *There will only be continuous evaluation for this course. The evaluation will be based on the performance of the student in the exercises given above. A minimum of 50% marks is required for a pass.*

23-204-0715 PROJECT PHASE I

Course Outcomes:

On completion of this course the student will be able to:

1. Conduct a comprehensive literature survey to identify and analyze a specific problem statement in Information Technology.
2. Formulate a well-structured project proposal by synthesizing literature insights and engaging with industry experts and academic mentors.
3. Develop a detailed execution plan for Phase II, including resource allocation, timeline, and risk management strategies.
4. Demonstrate technical communication skills through a properly formatted thesis document and professional PowerPoint presentations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1			1		1		1	3	3	1	1
CO2	3	3	3	3	1			1		1		1	3	3	1	
CO3	3	3	3	3	1			1		1		1	3	3	1	1
CO4	3	3	3	3	1			1		1		1	3	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

This course aims to equip undergraduate students in Information Technology. with the essential skills and knowledge required to successfully navigate through the initial phases of a project. Students will learn to conduct a comprehensive literature survey, identify and focus on a specific problem, formulate a project proposal, develop an execution plan for Phase II, and enhance their technical communication skills through thesis preparation and presentation techniques.

Topics to be Covered

Introduction to Literature Survey and Problem Identification: Understanding the significance of literature survey in research, Techniques for conducting a thorough literature review, identifying relevant areas of study within Information Technology., and Narrowing down to a specific problem statement.

Formulating a Project Proposal: Guidelines for structuring a project proposal, the importance of consultation with industry experts and academic mentors, incorporating insights from the literature survey into the proposal, Developing a clear and concise problem statement and objectives

Project Execution Planning: Principles of project management and planning, developing a detailed execution plan for Phase II of the project, identifying resources, timeline, and milestones.

Enhancing Presentation Skills: Understanding the elements of effective presentations, Techniques for engaging and communicating technical information, Hands-on practice sessions on preparing and delivering technical presentations, and Peer feedback and improvement strategies.

Technical Communication: Thesis Preparation- Structure and format of a thesis document, Guidelines for writing thesis chapters- introduction, literature review, methodology, results, discussion, conclusion, Typesetting using Word or LaTeX for professional thesis formatting. Prepare PPTs for technical presentation.

Assessment:

Guidelines for evaluation:		***Marks***
1.	Attendance and Regularity	10
2.	Literature Survey and Problem Identification	10
3.	Project Proposal	10
4.	Project Execution Plan	10
5.	Thesis and Presentation Skills Assessment	10
	Total	**50**

Note: Points (1)-(3) are to be evaluated by the respective project guides and project coordinator based on continuous evaluation. (4)-(5) to be evaluated by the final evaluation team comprising of 3 internal Examiners.

References:

1. Jesson, J. K., Matheson, L., & Lacey, F. M. (2011). Doing your literature review: Traditional and systematic techniques. SAGE.

2. Machi, L. A., & McEvoy, B. T. (2016). The literature review: Six steps to success (3rd ed.). Corwin Press.
3. Friedland, A. J., & Folt, C. L. (2009). Writing successful science proposals (2nd ed.). Yale University Press. https://doi.org/10.12987/9780300153654
4. Duarte, N. (2008). Slide:ology: The art and science of creating great presentations. O'Reilly Media, Inc.
5. Joyner, R. L., Rouse, W. A., & Glatthorn, A. A. (2018). Writing the winning thesis or dissertation: A step-by-step guide (4th ed.). Corwin, a SAGE Company.

23-200-0716 INTERNSHIP-III

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject of area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organization of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1			2	1		2	2	2	1	2
CO2	2	3	1	2	2	1			2	2	1	1	2	2		1
CO3	2	2	3	2	2	1			2	2	1	1	2	2		2
CO4	2	2	2	3	2	1			2	2	1	1	2	2		1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Internship Guidelines

- An internship plan has to be prepared by the interns incorporating the job description/internship duties, name of the project, if any and internship schedule and expected learning outcomes in consultation with industry supervisor/mentor and institute faculty.
- A detailed training report in the prescribed format shall be submitted at the end of the internship.
- Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
- The work shall be reviewed and evaluated periodically.
- Orientation of interns, resource requirement of interns, monitoring of interns progress on a daily basis shall be carried out by the industry offering internship in addition to ensuring safety and welfare of the interns

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

Guidelines for evaluation:

1.	Regularity and progress of work	10
2.	Work knowledge and Involvement	10
3.	Semester End presentation and oral examination	10
4.	Level of completion of the internship	10
5.	Internship Report – Presentation style and content	10
Total		**50** Marks

SEMESTER VIII

PROFESSIONAL ELECTIVE – IV

23-204-0801 BLOCK CHAIN TECHNOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. Understand emerging abstract models for Block chain Technology
2. Familiarize the functional/operational aspects of cryptocurrency
3. Understanding of the function of Block chain as a method of securing distributed ledgers,
4. Apply Hyperledger Fabric and Ethereum platform to implement the Block chain Application.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1					2				1	2	2	2	1
CO2	3	2	2					2				1	2	2	2	2
CO3	3	2	3					2	1			1	2	2	2	1
CO4	3	2	3	2				2					2	2	2	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Blockchain: Brief History of Blockchain, Decentralization, Ledgers, Distributed Ledgers and Consensus, Public and Private Ledgers.
Algorithms & Techniques: Cryptography, Hash Functions, Public Key Cryptography and Digital Signing, Blocks and Blockchain, Chain, Nodes and Network.

Module II

Blockchain Design Principles: Blockchain Structure, Basic Operations, Networked Integrity, Distributed Power, Security, Privacy, Rights Preserved, Inclusion.
Trust Framework and Consensus Mechanisms, Public, Consortium, Private Blockchains, Blockchain Interoperability

Module III

Ethereum Blockchain: Ethereum Structure, Ethereum Operations, Smart Contracts. Crypto currency Tokens, Wallets and the Marketplaces, Implications on Traditional Businesses.

Module IV

Blockchain-Recent Trends – Hyperledger, Corda. Uses of Blockchain in E-Governance, Land Registration, Medical Information Systems and Agriculture sectors

References :

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: A comprehensive introduction. Princeton University Press.
2. Imran, M. (2020). Mastering blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular blockchain frameworks. Packt Publishing Ltd.
3. Swan, M. (2015). Blockchain: Blueprint for a New Economy. O'Reilly Media.
4. Mougayar, W. (2016). The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology. John Wiley & Sons.
5. Antonopoulos, A. M. (2014). Mastering Bitcoin: Unlocking Digital Cryptocurrencies. O'Reilly Media..
6. Garay, J., Kiayias, A., & Leonardos, N. (2015). The bitcoin backbone protocol: Analysis and applications. In Annual International Conference on the Theory and Applications of Cryptographic Techniques (pp. 281-310). Springer, Cham.

23-204-0802 ROBOTIC PROCESS AUTOMATION

Course Outcomes:

On completion of this course the student will be able to:

1. Understand Robotic Process Automation technology.
2. Apply UiPath programming techniques to deploy robot configurations.
3. Learn Robotic Process Automation with Blue Prism.
4. Apply different technologies to Robotic Processing

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2				3			1			2	1		
CO2	3	3	3	2	1	3				1			2	2		
CO3	3		3		1					1			2	1		
CO4	3	3	3	3	1	3	3			1			2	2	1	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

What is Robotic Process, Automation Scope and techniques of automation, Lifecycle of RPA, Robotic process automation, RPA platforms Advantages of Robotic Process Automation, Myths of RPA, Desktop RPA, Introduction to RPA tools: I path, Blue Prism, Work Fusion.

Module II

UiPath Record and Play UiPath stack, Learning UiPath Studio Sequence, Flowchart, and Control Flow. Sequencing the workflow Activities Control flow, various types of loops, and decision making, Case Study.

Module III

Data Manipulation Variables and scope, Collections Arguments Purpose and use, Data table usage with examples, Clipboard management, File operation with example.
Taking Control of the Controls, Finding and attaching windows, Finding the control Techniques for waiting for a control, Act on controls, mouse and keyboard activities, Working with UiExplorer Handling events, Recorder Screen Scarping, OCR.
Tame the Application with Plugins and Extensions, Terminal plugin, SAP automation, Java plugin, Citrix automation, Mail plugin, PDF plugin, Web integration, Excel and Word plugins, Credential management, Extensions Java, Chrome, Firefox, and Silverlight.

Module IV

Robotic Process Automation with Blue Prism, An Overview of Blue Prism, The Technology of
Blue Prism, Creating Blue Prism Applications: Business Objects, Creating Blue Prism Applications: Processes, Deploying Blue Prism Applications, Managing Blue Prism Applications, Securing Blue Prism Applications.

References :

1. Tripathi, A. M. (2019). Learning robotic process automation. Apress. https://doi.org/10.1007/978-1-4842-4316-8
2. Casale, F. (2020). Introduction to robotic process automation: A primer. BP Trends.
3. Jain, V. (2019). Crisper learning: For Blue Prism. CRISP Learning.
4. Ying, L. M. (2020). Robotic process automation with Blue Prism quick start guide. Packt Publishing Ltd

23-204-0803- PATENTS AND INTELLECTUAL PROPERTY RIGHTS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals of Intellectual property rights, WTO, TRIP, and process of acquiring patents through case studies.
2. Explore the realm of Copyright and relevant acts such as the Copyright Act and IT Act 2000, with a focus on internet and copyright issues, illustrated through case studies.
3. Analyse Trademarks and Industrial Design, Geographical indications, trade secrets, and relevant case studies.
4. Create and manage Intellectual Properties and address emerging issues in IPR.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2			2		3		2			1			2
CO2	2	1	2			2		3		2			2			2
CO3	2	1	2			2		3		2			2			2
CO4	2	1	2			2		3		2			1			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to intellectual property rights (IPR): Definition of intellectual property, intellectual property vs physical property, Introduction to WTO and TRIP, Types of IPR, Fundamentals of patent, Inventions which are not patentable, process and product patent, Registration Procedure, Rights and Duties of Patentee, Transfer of patent- Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement of patent rights, remedies, penalties, challenges in patents. Case study.

Module II

Copyright: Definition & Types of Copyright, Registration procedure, ownership of copyright, Assignment and license, Rights of the owner, Terms of Copyright, Piracy, Infringement, Remedies, The copyright Act, The IT Act 2000, Internet and copyright issues, case study

Trademarks: Meaning of trademark, conditions of registration, Registration process, term of trademark, assignment and transmission, Infringement & Remedies, Offenses relating to Trademarks, cybersquatting, Passing Off, Penalties, case study

Module III

Design: industrial designs, conditions for registration, registration process, term of industrial design, infringement and remedies, Integrated circuit layout design, trade secrets, case study. Geographical indications (GI): Concept and definition of GI, Geographical indication in India, duration and renewal of GI, infringement, status, benefits of registration of GI. Case study

Module IV

Creating intellectual property (IP): Need for creating intellectual property, process of development of IP and knowledge, Types of innovations, appropriations of intellectual property, behavioral aspects.

Intellectual property management: Definition, need and importance, major IP management activities, 5 Cs model of managing IP. Emerging issues in IPR.

References :

1. Pandey, N., & Dharni, K. (2014). Intellectual property rights. PHI Learning Pvt. Ltd.
2. Bainbridge, D. (2018). Intellectual property (10th ed.). Pearson Education Limited.
3. Sople, V. V. (2014). Managing intellectual property rights. PHI Learning Pvt. Ltd.
4. Ganguli, P. (2001). Intellectual property rights: Unleashing the knowledge economy. Tata McGraw-Hill Education.
5. Cornish, W., Llewelyn, D., & Aplin, T. (2013). Intellectual property: Patents, copyright, trade marks and allied rights (8th ed.). Sweet & Maxwell.
6. WIPO. (2004). WIPO intellectual property handbook: Policy, law and use (2nd ed.). WIPO.
7. Lemley, M. A. (2015). Intellectual property in the new technological age (Vol. I). Wolters Kluwer Law & Business.
8. Ghosh, S., & Calboli, I. (2018). Intellectual property law. Oxford University Press

23-204-0804 CYBER LAWS & INFORMATION SECURITY

Course Outcomes:

On completion of this course the student will be able to:

1. Identify security threats in computing, database, network etc.
2. Apply Cryptographic techniques to secure the data.
3. Formulate security requirements for data and networks, assess the reliability and integrity of information.
4. Justify the need for information security policies, and appraise the relevance of international standards

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	2	2				1					2	2	2	
CO2	3	2	2	2				1					2	2	2	
CO3	2	1	2	2				1					2	2	2	
CO4	1	1	2	2				2					2	2	2	

1-Slightly; 2-Moderately; 3-Substantially

Module I

Security Problem in Computing: Characteristics of computer intrusion, Attacks, Computer Criminals Program Security: Viruses and Other Malicious Code, Targeted Malicious Code, Controls against Program Threats.

Module II

Cryptography: Terminology and Background, Substitution Ciphers, Transpositions, Characteristics of good Encryption Algorithms, Data Encryption Standard, AES Encryption Algorithm, Public Key Encryption, The Uses of Encryption.

Module III

Data and Networking Security: Security Requirements, Reliability and Integrity, Sensitive Data, Inference Security in Networks: Threats in Networks, Network Security Controls, Firewalls.

Module IV

Security Policies and Cyber Laws: Need for an Information Security Policy, Information Security Standards, ISO, Introducing Various Security Policies and Their Review Process, Introduction to Indian Cyber Law, Objective and Scope of the IT Act 2000, Intellectual Property Issues, Overview of Intellectual Property Related Legislation in India, Patent, Copyright, Law Related to Semiconductor Layout and Design, Software License

References:

1. Pfleeger, C. P., & Pfleeger, S. L. (2023). Security in Computing (6th ed.). Prentice Hall Professional Technical Reference.
2. Tripathi, S., Goel, R. K., & Shukla, P. K. (2019). Introduction to information security and cyber laws. John Wiley & Sons.
3. Pachghare, V. K. (2008). Cryptography and information security. PHI Learning Pvt. Ltd.
4. Stallings, W. (1999). Cryptography and network security: Principles and practice (2nd ed.). Prentice Hall.
5. Chander, H. (2012). Cyber laws and IT protection. PHI Learning Pvt. Ltd.

PROFESSIONAL ELECTIVE – V

23-204-0805 SOFTWARE QUALITY AND TESTING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
2. Understand about software quality management.
3. Analysis different types of testing
4. Evaluate the techniques and skills on how to use modern software testing tools to support software testing projects.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2		1	1	3				2	2		3	2	2		
CO2	2	1										2	2	2		
CO3	3	2	2	2									2	2		
CO4	3	2	2							1		2	2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Quality Assurance Basics: Definition of Quality, Total Quality management. Four Dimensions of Quality: Specification Quality, Design Quality, Development Quality, Conformance Quality, Software Product Quality: white box standpoint vs functionality standpoint, Program Quality.

Module II

Quality Assurance department: Role, position, organisation and staffing. Software Verification: walkthrough, inspections, audits, process. Validation: Definition, software designs, product specification, software product. Familiarization with testing tools like Selenium.

Module III

Principles of Testing, Software Development Life Cycle Models. Types of Testing: White Box Testing, Black Box Testing, Integration Testing, System and Acceptance Testing, Performance Testing, Regression Testing, Internationalization (I18n) Testing, Ad hoc Testing, Usability and Accessibility Testing.

Module IV

People and organizational issues in testing: Common People Issues, Organization Structures for Testing Teams, Test Planning, Management, Execution, and Reporting. Test Management and automation: Software Test Automation, Test Metrics and Measurements

References :

1. Chemuturi, M. (2010). Mastering software quality assurance: Best practices, tools and techniques for software developers. J. Ross Publishing.
2. Dustin, E., Garrett, T., & Gauf, B. (2021). Implementing effective software testing: A process-oriented guide. Addison-Wesley Professional.
3. Patton, R. (2020). Software testing (4th ed.). Sams Publishing.
4. Desikan, S., & Ramesh, G. (2006). Software testing: Principles and practices. Pearson Education India.
5. Graham, D., Van Veenendaal, E., & Evans, I. (2008). Foundations of software testing: ISTQB certification. Cengage Learning EMEA.
6. Beizer, B. (2003). Software testing techniques (2nd ed.). Dreamtech Press.
7. Myers, G. J., Badgett, T., & Thomas, T. M. (2004). The art of software testing (2nd ed.). John Wiley & Sons.
8. Tian, J. (2005). Software quality engineering: Testing, quality assurance, and quantifiable improvement. John Wiley & Sons. https://doi.org/10.1002/0470091278
9. Kan, S. H. (2003). Metrics and models in software quality engineering (2nd ed.). Addison-Wesley Professional.

23-204-0806 ELECTRONIC BUSINESS AND SERVICES

Course Outcomes:

On completion of this course the student will be able to:

1. Develop the skills to design e-business solutions that align with organizational goals.
2. Understand the principles of e-business architecture and how to integrate various applications into a cohesive system.
3. Learn the importance of customer relationship management (CRM) in e-business and how to implement effective CRM strategies.
4. Understand the concepts of supply chain management and e-procurement, and their impact on business efficiency and cost reduction.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2									3	1		1
CO2	2	1	3	2	2								2	2		1
CO3	1		1	2		3							2	1		1
CO4	1	2	2	2			3						2	2		1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

E-Commerce to E-Business: Defining E-business, development of new economy, Types of e business. E-business markets and models, E-business environment, market places, models, Types of E-business models, Framework for analyzing E-business.

E-Business Trend Spotting: Increase Speed of Service, Self Service, Provide Integrated Solutions, Integrate Sales and Service, Customization and Integration, Customer Service Consistent and Reliable, Service Delivery, Contract Manufacturing, Increase Process Visibility, Employee Retention, Integrated Enterprise Applications, Multichannel Integration.

Module II

E-Business Design: Technology, Constructing an E-Business Design, Self Diagnosis, Reversing the Value Chain, Choosing a Narrow Focus, Case Study

E- Business Architecture: Functional Integrated Apps, Integrating Application Clusters into an E- Business Architecture, Aligning the E- Business Design with Application Integration.

Module III

Customer Relationship Management: Integrating Processes to Build Relationships, Customer Relationship Management, Definition, Organizing around the Customer, CRM Architecture, CRM Infrastructure, Implementing CRM, CRM Trends, Building a CRM Infrastructure Selling Chain Management: Transforming Sales into Interactive Order Acquisition, Defining Selling Chain Management, Business Forces Driving the Need for Selling, Technology Forces Driving the Need for Selling, Managing the Order Acquisition Process. Enterprise Resource Planning: The E-Business Backbone, ERP Decision, Enterprise Architecture Planning, ERP Implementation.

Module IV

Supply Chain Management: Inter enterprise Fusion, Defining Supply Chain Management, Basics of Internet Enabled SCM, E-Supply Chain Fusion, Management Issues.

E Procurement: The Next Wave of Cost Reduction, Isolated Purchasing to Real Time Process Integration, Operating Resource Procurement, Lack of Process Integration. Business Intelligence: Introduction to Knowledge Management Applications and BI.

References :

1. Turban, E., & King, D. (2017). Electronic Commerce 2018: A Managerial and Social Networks Perspective. Springer.
2. Laudon, K. C., & Traver, C. G. (2018). E-commerce 2017: Business, Technology, Society. Pearson.
3. Kalakota, R., & Robinson, M. (2001). E-business 2.0: Roadmap for success (2nd ed.). Addison-Wesley Professional.
4. Combe, C. (2006). Introduction to e-business: Management and strategy. Butterworth-Heinemann.
5. Almeida, V. (2001). Scaling for e-business: Technologies, models, performance, and capacity planning. Prentice Hall Professional.
6. Deitel, H. M., & Deitel, P. J. (2001). The complete e-commerce and e-business programming training course. Prentice Hall Professional.

23-204-0807 RESEARCH METHODOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. Get introduced to research philosophy and processes in general.
2. Formulate the problem statement and prepare research plan for the problem under investigation.
3. Apply various numerical /quantitative techniques for data analysis.
4. Communicate the research findings effectively.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1					3		1			3	2		
CO2	3	3						3		1	1		3	2		
CO3	2	3	3			2							2	2		
CO4	2	2	3	3						1			2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction: Concepts of Research, Meaning and Objectives of Research, Research Process, Types of Research, Criteria of Good Research, Research Problem Identifying and Defining, Research Proposals Types, contents, Sponsoring agency's requirements, Ethical aspects, IPR issues like patenting, copyrights etc.

Module II

Research Design Meaning, Need and Types of research design, Literature Survey and Review, Research Design Process, Measurement and scaling techniques, Data Collection concept, types and methods, Processing and analysis of data, Design of Experiments.

Module III

Quantitative Techniques Sampling fundamentals, Testing of hypothesis using various tests like ANOVA, Chi square test, Multivariate analysis, Applications of various statistical softwares.

Module IV

Computer Applications Pre-writing considerations, Principles of Thesis Writing, Formats of Report Writing & Publication in Research Journals, Documentation and presentation tools LATEX, Microsoft Office with basic presentations skills, Use of Internet and advanced search techniques.

References :

1. Melville, S., & Goddard, W. (2018). Research methodology: An introduction. Juta and Company Ltd.
2. Kumar, R. (2019). Research methodology: A step-by-step guide for beginners (6th ed.). SAGE Publications Limited.
3. Kothari, C. R. (2004). Research methodology: Methods and techniques (3rd ed.). New Age International.
4. Ramamurthy, G. C. (2014). Research methodology. Dreamtech Press.
5. Krishnaswamy, K. N., Sivakumar, A. I., & Mathirajan, M. (2019). Management research methodology: Integration of principles, methods and techniques (2nd ed.). Pearson Education India

23-204-0808 COGNITIVE COMPUTING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals of human cognition and machine cognition.
2. Analyze the different design principles of cognitive systems.
3. Understanding how advanced technologies integrated with cognitive systems
4. Implement basics of cognitive analytics methods.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2										2	2	1		
CO2	3	2	1	1								1	1	2		
CO3	2	3	2	1	1				1			1	2	1		
CO4	3	2	1									1	2	1		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction: Artificial Intelligence and Cognitive Computing. Understanding cognition, Two systems of Judgement and choice Automatic thinking: Intuition and Biases, Controlled Rule– Centric and concentrated effort. Understanding complex relationship between systems, Elements of Cognitive Systems. Cognitive Applications.

Module II

Design Principles: Components of Cognitive Systems. Bringing Data into Cognitive Systems, Leveraging Internal and External Data Sources, Data access and Feature extraction services. Machine Learning: Finding Patterns in the Data, Hypothesis Generation and Scoring.

Module III

Cognitive Systems: Natural Language Processing and Cognitive Systems, Role of NLP in Cognitive Systems, Semantic Web. Relationship between Big Data and Cognitive Computing. Role of Cloud and Distributed Computing in Cognitive Computing

Module IV

Cognitive Analytics: Applying advanced analytics to cognitive computing, Key capabilities in advanced analytics, Relationship between Statistics, Data Mining and Machine Learning. Machine Learning in Analytics process. Predictive analytics, Text analytics, Image analytics, Speech analytics. Using Advanced analytics to create Value, Building Value within memory capabilities. Impact of Open Source Tools on Advanced Analytics.

References:

1. Dhar, V. (2018). Cognitive Computing: A Brief Guide for Game Changers. Wiley.
2. Jain, V., Tayal, A., Singh, J., & Solanki, A. (2021). Cognitive Computing Systems: Applications and Technological Advancements (1st ed.). New York: Apple Academic Press. https://doi.org/10.1201/9781003082033
3. Vernon, D. (2014). Artificial cognitive systems: A primer. MIT Press. https://doi.org/10.7551/mitpress/9780262027678.001.0001
4. Hurwitz, J. S., Kaufman, M., & Bowles, A. (2015). Cognitive computing and big data analytics. John Wiley & Sons.
5. Watson, M. (2017). Introduction to cognitive computing: A guide for individuals and small organizations. Independently published.
6. Raghavan, V. V., & Gudivada, V. N. (2015). Cognitive computing: Theory and applications. Elsevier. https://doi.org/10.1016/C2014-0-03492-7

PROFESSIONAL ELECTIVE -VI

23-204-0809 DIGITAL TWIN TECHNOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the Fundamentals of Digital Twin
2. Explore Digital Twin Technologies and Architectures:
3. Implement data integration and preprocessing techniques for Digital Twins.
4. Identify and address security and privacy considerations in the implementation of Digital Twins

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2		3	2	1			2	1	3	2		2
CO2	3	3	3	2	2	3	2	1			2	1	3	2		2
CO3	2	3	3	3	2	3	2	1			2	1	3	2		2
CO4	2	2	2	3	2	3	2	1			2	1	3	2		2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Digital Twins: Definition and concept, Historical evolution, Importance and applications across various industries (manufacturing, healthcare, urban planning, etc.), Components of Digital Twins

Module II

Digital Twin Technologies and Architectures: Physical assets and virtual models, Sensor technologies and data acquisition, Connectivity and communication protocols (MQTT, CoAP), Edge computing and cloud computing in Digital Twins. Types of models (physics-based, data-driven, hybrid), Simulation techniques -machine learning models, Model validation and calibration, Data Management and Analytics

Module III

Data integration and preprocessing, Real-time data processing and streaming analytics, Overview of commercial and open-source digital twin platforms, Integration with existing enterprise systems (ERP, PLM, SCM), Visualization tools and user interfaces, Interoperability and Standards

Module IV

Security and privacy considerations, Application of Digital Twins: Digital twins in manufacturing (Industry 4.0, smart factories), Digital twins in healthcare (personalized medicine, patient monitoring), Digital twins in smart cities (urban planning, infrastructure management).

Case Study: Developing a simple digital twin using simulation software, Integrating sensor data with a digital twin model, Analyzing and visualizing data from a digital twin

References :

1. Lu, Y., & Wang, B. (2021). Digital Twin Technology and its Industrial Applications. Springer.
2. Tao, F., & Zhang, H. (2020). Digital Twin Driven Smart Manufacturing. Academic Press.
3. Lu, Y., Morris, K. C., Frechette, S., & Thoben, K. D. (2017). Standards landscape and directions for digital twin. IEEE Standards Association.
4. Lee, J. H., Phaal, R., & Lee, S. H. (2013). An integrated service-device-technology roadmap for smart city development. Technological Forecasting and Social Change, 80(2), 286-306. https://doi.org/10.1016/j.techfore.2012.09.020
5. Tao, F., Cheng, J., Qi, Q., Zhang, M., & Zhang, H. (2019). Digital twin-driven product design, manufacturing and service with big data. International Journal of Advanced Manufacturing Technology, 100(5), 2463-2476. https://doi.org/10.1145/2684822.2684873

23-204-0810 WIRELESS NETWORKING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals of cellular networks and broadband communication
2. Comprehend the basics of transmission and communication networks
3. Analyse the concepts of antennas and propagation, signal encoding techniques, spread spectrum, and coding and error control in the context of wireless communication
4. Explore wireless networking and LANs

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1									3	1	3	1
CO2	3		2										3	2	1	
CO3	1	3		1									2			1
CO4	2		3	3									2	1	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction: Cellular Revolution, Global Cellular Network, Broadband. Transmission Fundamentals: Signals for Conveying Information, Analog and Digital Data Transmission, Channel Capacity, Transmission Media, Multiplexing. Communication Networks: Switching Techniques, Circuit Switching, Packet Switching, Asynchronous Transfer Mode.

Module II

Wireless Communication Technology: Antennas and Propagation, Signal Encoding Techniques, Spread Spectrum, Coding and Error Control.

Module III

Wireless Networking: Satellite Communications, Cellular Wireless Networks, Cordless Systems and Wireless Local Loop, Mobile IP and Wireless Access Protocol.

Module IV

Wireless LANs: Wireless LAN Technology, Wi-Fi and the IEEE 802.11 Wireless LAN Standard, Bluetooth and IEEE 802.15.

References:

1. Stallings, W. (2009). Wireless communications and networks (2nd ed.). Pearson Education India.
2. Goldsmith, A. J. (2020). Wireless Communications. Cambridge University Press.
3. Molisch, A. F. (2018). Wireless Communications. Wiley.
4. Kurose, J. F., & Ross, K. W. (2013). Computer networking: A top-down approach (6th ed.). Pearson.
5. Segars, S. (2021). Low power wireless communication networks and the internet of things: Bluetooth, Zigbee, and Wi-Fi protocols. CRC Press. https://doi.org/10.1201/9781003050229
6. Muller, N. J. (2001). Bluetooth demystified. McGraw Hill Professional.
7. Umar, A. M. (2004). Mobile computing and wireless communications: applications, networks, platforms, architectures, and security. NGE Solutions, Inc.

23-204-0811 COMPUTER VISION AND TRANSFORMERS

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze and implement key computer vision techniques including image processing, feature extraction, object recognition and generative models.
2. Design and train convolutional neural networks (CNNs) for image classification and other computer vision tasks.
3. Apply transformer models and self-attention for sequence modeling tasks like machine translation and text generation.
4. Build transformer-based models like Vision Transformers (ViT) for image recognition and segmentation, leveraging transfer learning.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3											3	2		
CO2	3	3	3	2	3								3	2		
CO3	2	3	3	2		3							2	3		
CO4	2	2	3	3			3				3		2	3		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Computer Vision. Image formation and camera models. Noise modeling and filtering. Feature extraction: corners, edges, scale/orientation. Model fitting: lines, curves and transformations. Object recognition and classification.

Module II

Deep Learning for Computer Vision. Convolutional Neural Networks (CNNs). CNN architectures for image classification. Deep learning for object detection, segmentation. Generative models: Autoencoders, GANs. Advanced vision topics: SLAM, motion tracking.

Module III

Sequence Modeling with Transformers. Recurrent Neural Networks. Attention and self-attention. Transformer architecture. Training techniques for transformers. Applications in machine translation, text generation.

Module IV

Transformers for Computer Vision. Vision Transformer (ViT). CNN-Transformer hybrid models. Image recognition with transformers. Segmentation with transformers. Multimodal learning: text, vision and speech. Transfer learning with pretrained models.

References:

1. Szeliski, R. (2010). Computer vision: algorithms and applications. Springer Science & Business Media.
2. Hartley, R., & Zisserman, A. (2003). Multiple view geometry in computer vision (2nd ed.). Cambridge university press.
3. Jähne, B. (2005). Digital image processing (6th ed.). Springer.
4. Karpathy, A. (2022). convolutional neural networks for visual recognition. Stanford University.
5. Albawi, S., Mohammed, T. A., & Al-Zawi, S. (2017, August). Understanding of a convolutional neural network. In 2017 International Conference on Engineering and Technology (ICET) (pp. 1-6). IEEE.
6. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. Advances in neural information processing systems, 30.
7. Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2018). Bert: Pre-training of deep bidirectional transformers for language understanding. arXiv preprint arXiv:1810.04805.
8. Carion, N., Massa, F., Synnaeve, G., Usunier, N., Kirillov, A., & Zagoruyko, S. (2020). End-to-end object detection with transformers. Machine Learning and Systems, 2(3), 187-213.

23-204-0812 REAL TIME SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand real-time systems' basics, scheduling algorithms, and timing constraints.
2. Manage resource sharing, priority protocols, and benchmark real-time operating systems.
3. Implement real-time communication in LANs and packet-switched networks with QoS models.
4. Develop real-time databases with appropriate concurrency control protocols.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3				3						3	2		
CO2	3	2	3		3		3						3	2		
CO3	3	2	3	2			3						2	2		
CO4	3		3	2	3		3						2	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction: Basic Model, Characteristics and applications of real time systems, Safety and Reliability, Types of Real Time Tasks, Timing Constraints. Real Time Task Scheduling: clock driven scheduling, event driven scheduling, Rate monotonic algorithm. Scheduling Real time Tasks in Multiprocessor and distributed systems. Clocks in distributed real time systems.

Module II

Introduction: Basic Model, Characteristics and applications of real time systems, Safety and Reliability, Types of Real Time Tasks, Timing Constraints. Real Time Task Scheduling: clock driven scheduling, event driven scheduling, Rate monotonic algorithm. Scheduling Real time Tasks in Multiprocessor and distributed systems. Clocks in distributed real time systems.

Module III

Real Time Communication: Basic concepts, Real time communication in a LAN, Bounded access protocols for LANs, Real time communication over packet switched networks, Routing, Resource reservation, Rate control, QoS Models.

Module IV

Real Time databases: Applications of real time databases, real time database application design issues, characteristics of temporal data, concurrency control in real time databases, locking based concurrency control protocols, optimistic concurrency control protocols, speculative control protocols.

References :

1. Mall, R. (2008). Real-time systems: Theory and practice. Dreamtech Press.
2. Jane W. S. Liu, Liu. (2006). Real-time systems. Prentice Hall.
3. Laplante, P. A., & Ovaska, S. J. (2020). Real-time systems design and analysis: Tools for the practitioner (5th ed.). Wiley-IEEE Press.
4. Buttazzo, G. C. (2011). Hard real-time computing systems: Predictable scheduling algorithms and applications (3rd ed.). Springer. https://doi.org/10.1007/978-1-4614-0676-1
5. Kopetz, H. (2011). Real-time systems: Design principles for distributed embedded applications (2nd ed.). Springer. https://doi.org/10.1007/978-1-4419-8237-7
6. Prasad, K. V. (2005). Embedded/real-time systems: Concepts, design & programming. Dreamtech Press.
7. Douglass, B. P. (2004). Real time UML: Advances in the UML for real-time systems (3rd ed.). Addison-Wesley Professional.

OPEN ELECTIVE – II

23-204-0813 SOFTWARE PROJECT MANAGEMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental principles of project management including the essentials of project initiation, stakeholder management, and risk assessment.
2. Acquire practical skills in constructing a Work Breakdown Structure (WBS) for software projects.
3. Develop techniques for Project Monitoring, Control, and Closures.
4. Explore the evolution of Agile methodologies and learn about iterative development, continuous integration, and the importance of metrics in monitoring and adapting Agile projects.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2				1		1			2	2	2	1		1
CO2	3	2	1	1							2	1	1	2		1
CO3	2	3	2	1	1	1			1		2	1	2	1		1
CO4	3	2	1								2	1	2	1		1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Software Project Management: Overview of project management principles, Importance of project management in software development, Key challenges in software project management.
Project Initiation: Defining project objectives and scope, Stakeholder analysis and management, Project feasibility and risk assessment.
Project Planning: Work breakdown structure (WBS), Estimation techniques: expert judgment, analogy, parametric estimation, Project scheduling using Gantt charts, Resource allocation and management.

Module II

Risk Management: Identifying and analyzing project risks, Risk mitigation strategies.
Project Execution: Team formation and collaboration, Communication Management, Managing project changes, Quality assurance and control.
Quality Management: Quality planning and assurance, Quality control techniques and tools, Continuous process improvement, Metrics for measuring project and product quality.

Module III

Project Monitoring and Control: Progress tracking, Earned Value Management (EVM), Performance reporting and analysis, Change management. Software Configuration Management.
Stakeholder Management: Understanding stakeholder expectations, Stakeholder communication and engagement strategies, Resolving conflicts and managing stakeholder relationships.
Project Closure: Criteria for project closure, Lessons learned documentation, Transitioning deliverables to stakeholders, Post-implementation review, Celebrating project success and team recognition.

Module IV

Project Documentation and Reporting: Types of project documentation, Document management systems, Reporting tools and techniques.
Agile Project Management: Agile principles and values, Benefits and challenges of Agile project management, Agile methodologies (Scrum, Kanban, XP).

References :

1. Villafiorita, A. (2016). Introduction to software project management. Auerbach Publications.
2. Dutt, & Chandramouli. (2015). Software project management. Pearson India.
3. DeMarco, T., & Lister, T. (2013). Waltzing with bears: Managing risk on software projects. Addison-Wesley Professional.
4. Pressman, R. S. (2019). Software engineering: A practitioner's approach (8th ed.). McGraw-Hill.
5. Thayer, R. H. (2006). Software engineering project management (2nd ed.). Wiley Student Edition.
6. A Guide to the Project Management Body of Knowledge (PMBOK Guide) by Project Management Institute (PMI).
7. Jeff Sutherland. Scrum: The Art of Doing Twice the Work in Half the Time
8. Shore, J., & Warden, S. (2020). The art of agile development (2nd ed.). O'Reilly Media, Inc.
9. Hesselberg, J. (2018). Unlocking agility: An insider's guide to agile enterprise transformation. Addison-Wesley Professional.
10. Hooda, S., Sood, V. M., Singh, Y., Dalal, S., & Sood, M. (2023). Agile software development. Wiley-Scrivener. https://doi.org/9781119896395

23-204-0814 SOCIAL COMPUTING

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze computational models underlying social computing.
2. Understand social learning aspects of knowledge management, agents and social interaction.
3. Analyse security and identity in cyberspace.
4. Evaluate the services provided by social networks

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1					1			1	3	3		
CO2	3	3	2	1					1			1	3	3		1
CO3	3	2	2	1					1			1	3	2	2	
CO4	3	2	2	2					1			1	3	2		1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Social Influence and Human Interaction with Technology, Social and Human Elements of Information Security: A Case Study, Computer Mediated Communication, Learning Environments, Online Communities and Social Networking, IT and the Social Construction of Knowledge.

Module II

Social Learning Aspects of Knowledge Management, Agents and Social Interaction: Insights from Social Psychology Social Perception, Agent Based Modelling and Social Psychological Theory.

Module III

Cyber identities and Social Life in Cyberspace, Online Learning, Social Presence, Social Networking, Social Networking Analysis, Social Networking Services. Social Networks in information Systems: Tools and Services.

Module IV

Mobile Social Networks and Services, Social Software, Self Organization in Social Software for Learning, Mailing Lists and Social Semantic Web.

References :

1. Dasgupta, S. (2020). Social computing: Concepts, methodologies, tools, and applications (2nd ed.). IGI Global. https://doi.org/10.4018/978-1-60566-984-7
2. Liu, H., Salerno, J. J., & Young, M. J. (2020). Social computing, behavioral-cultural modeling and prediction (2nd ed.). Springer Science & Business Media. https://doi.org/10.1007/978-1-4419-6281-2
3. Kamal, R. (2022). Mobile computing (3rd ed.). Oxford University Press.
4. Talukder, A., & Yavagal, R. (2019). Mobile computing: Technology, applications, and service creation (3rd ed.). McGrawHill Professional.

23-204-0815 ETHICAL HACKING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand steps in hacking.
2. Analyse Information security threats and countermeasures.
3. Illustrate the issues relating to ethical hacking.
4. Analyse session Hijacking, SQL Injection and security in various aspects.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2						2				1	2	2	1	1
CO2	3	2						2				1	2	2	2	
CO3	3	2						2	1			1	2	2	2	
CO4	3	2	3					2					2	2	2	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Ethical Hacking Overview & Vulnerabilities: Evolution of hacking, Ethical Hacker Code of Conduct and Ethics, Hacking Methodologies, Incident Response Ethics and the Law Introduction to steps in Ethical Hacking.

Module II

Foot printing and Scanning: Foot printing, Need and Goals of foot printing, Terminologies, Threats, The Foot printing Process. Scanning, Introduction, Types of scans, Checking the Status of Ports, The Family Tree of Scans, OS Fingerprinting.

Module III

Enumeration and System Hacking: Enumeration, Enumeration in different OS, SMTP Enumeration. System Hacking: Password Cracking, Authentication on Microsoft Platforms, Executing Applications, Covering tracks.

Module IV

Session Hijacking and Sql Injection: Session Hijacking, Spoofing, Hijacking, Application Level and Network Session Hijacking, Defensive Strategies.
SQL Injection, Results and Anatomy of a SQL Injection, Attack Altering Data, Injecting Blind Information Gathering Evading, Detection Mechanisms, Counter measures. Hacking Wi-Fi and Bluetooth, Mobile Device Security

References:

1. Mittal, A., & Kakkar, M. (2022). Ethical hacking: A hands-on introduction to breaking in. Pearson Education.
2. Kim, D. (2021). The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws (2nd ed.). Wiley..
3. Graves, K. (2010). Certified ethical hacker (CEH) ,. John Wiley & Sons
4. Simpson, M. T. (2010). Hands-on ethical hacking and network defense. Cengage Learning.
5. Khare, R. (2006). Network security and ethical hacking. Luniver Press.
6. Ramachandran, V. (2011). Backtrack 5 wireless penetration testing beginner's guide. Packt Publishing Ltd.
7. Thomas, M. (2003). Ethical hacking. OSB publishers.

23-204-0816 ARM PROCESSOR TECHNOLOGY

Course Outcomes:

On completion of this course the student will be able to:

1. Gain insight into the history, evolution, applications, and processor families of ARM processors, as well as the essential role of Firmware, Operating Systems, and cache in ARM Embedded systems.
2. Examine the ARM processor architecture, memory architecture, and the significance of the Thumb mode of operation.
3. Implement ARM assembly language programs using appropriate syntax, instruction sets, and addressing modes.
4. Explore advanced ARM features including heterogeneous processing, security mechanisms, and multimedia extensions.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2			1						1		2	2		
CO2	3	3	3	3	3		2				1		3	2		1
CO3	3	3	3	3	3						1		3	2		
CO4	3	1		2	1		2				1		2	2	3	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to embedded system and ARM Processor, Origins of ARM architecture, Transition from desktop to embedded and mobile devices, Overview of ARM-related companies and opportunities, ARM processor family, Applications of ARM Processors in Mobile devices (smartphones, tablets), Embedded systems (Internet of Things, wearables), Networking and telecommunications equipment, Automotive and industrial control systems, Consumer electronics (multimedia players, gaming consoles), Server and cloud computing (ARM-based server processors) etc. Firmware and Bootloader. Fundamental Components of Embedded Operating Systems. Compiler. Emulation and Debugging. Difference between RISC & CISC.

Module II

ARM Processor Architecture and Design Principles: ARM pipeline architecture, 3-stage pipeline ARM organization, 5-stage pipeline ARM organization, Understanding of ARM instruction execution, Exceptions in ARM, Thumb programmer's model and instruction set, ARM instruction set families (ARM, Thumb, Thumb-2), ARM memory hierarchy , The memory Hierarchy and caches memory, Cache architecture basic architecture of caches memory, basic operation of cache controller, the relationship between cache and main memory, ARM exception handling and interrupt processing.

Module III

Memory Management and ARM Assembly Programming: ARM memory architecture, ARM memory architecture, Memory types:- RAM,ROM, UVROM, FLASH Memory, DRAM. Address translation and memory protection, addressing modes (register, immediate, indexed), ARM Assembly Language Programming, ARM assembly language syntax, Data types and directives, ARM instruction set (arithmetic, logical, branch, load/store), Conditional execution.

Module IV

ARM Programming Advanced Topics and Features: Introduction to ARM development tools (assemblers, compilers), Setting up a development environment (e.g., Keil, GCC),Writing simple ARM assembly programs, Overview of ARM Processor Families and Features: Cortex-A series (high-performance applications), Cortex-R series (real-time applications),Cortex-M series (microcontroller applications), big.LITTLE and DynamIQ heterogeneous processing, ARM TrustZone security technology, NEON SIMD engine for multimedia and signal processing

References:

1. Furber, S. (2013). ARM System-on-Chip Architecture (2nd ed.). Pearson.
2. Smith, S. (2020). Programming with 64-Bit ARM Assembly Language: Single Board Computer Development for Raspberry Pi and Mobile Devices. Apress. ISBN: 9781484258811.
3. Sloss, A., Symes, D., & Wright, C. (2004). ARM System Developer's Guide. Morgan Kaufmann.

4. Hohl, W. (2019). ARM assembly language: Fundamentals and techniques (2nd ed.). CRC Press.
5. Yiu, J. (2013). The definitive guide to ARM Cortex-M3 and Cortex-M4 processors (3rd ed.). Newnes.
6. ARM Limited. (2020). ARM Cortex-A processor series (Technical Reference Manual). https://developer.arm.com/documentation/ddi0595/latest
7. ARM Limited. (2021). ARM Cortex-M processor series (Technical Reference Manual). https://developer.arm.com/documentation/ddi0337/latest.

23-200-0817 CONSTITUTIONAL LAW

Course Outcomes:

On completion of this course the student will be able to:

1. Configure the preamble and fundamental rights.
2. Actuate the governance and functioning of constitutional functionaries.
3. Describe the functions of legislative bodies.
4. Decipher the judiciary system and its role in governance

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1						2	1	2	2			2				1
CO2						2	1	2	2			2				1
CO3						2	1	2	2			2				1
CO4						2	1	2	2			2				1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction

Constitution Law – Constitutional Assembly Debates – Constitution of India – Basic Features of Indian Constitution – Preamble – Structure and Content of Indian Constitution

Module II

Fundamental Rights

Rights – Fundamental Rights – Definition of State – Fundamental Rights under Indian Constitution – Right to Equality – Untouchability – Title – Right to Life Cultural and Educational Rights of Minorities - Enforcement of Fundamental Rights

Module III

Directive Principles of State Policy & Fundamental Duties

DPSP's – Relationship between DPSP and Fundamental Rights – Conversion of DPSP into Fundamental Rights – Role of Judiciary – Judicial Activism – PIL - Fundamental Duties

Module IV

Constitutional Organs

Legislative Organs – Parliament – Lok Sabha, Rajya Sabha - State Legislatures - Executive Organs - President, Vice President, Council of Ministers - Judicial Organs – Supreme Court and High Courts – Other Constitutional Bodies – Election Commission - Comptroller and Auditor General of India, etc.

References :

1. Basu, D. D. (2019). Introduction to the Constitution of India (24th ed.). LexisNexis.
2. Gupta, D. C. (2018). Indian government and politics (8th ed.). Vikas Publishing House.
3. Sreevai, H. M. (2015). Constitutional law of India (4th ed., Vols. 1-3). Universal Law Publishing

23-204 -0818 SEMINAR

Course Outcomes:

On completion of this course the student will be able to:

1. Identify and familiarize with some of the good publications and journals in their field of study.
2. Acquaint oneself with preparation of independent reports, name them based on a central theme and write abstracts, main body, conclusions, and references identifying their intended meaning and style.
3. Understand effective use of tools of presentation, generate confidence in presenting a report before an audience and improve their skills in the same.
4. Develop skills like time management, leadership quality and rapport with an audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1			1		1		1	3	3	1	1
CO2	3	3	3	3	1			1		1		1	3	3	1	1
CO3	3	3	3	3	1			1		1		1	3	3	1	1
CO4	3	3	3	3	1			1		1		1	3	3	1	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Instructions

- Students shall individually prepare and submit a seminar report on a topic of current relevance related to the field of Information Technology and trends.
- The references shall include standard journals, conference proceedings, reputed magazines, and textbooks, technical reports, and URLs.
- The references shall be incorporated in the report following IEEE standards reflecting the state of the art in the topic selected.
- Each student shall present a seminar for about 30 minutes duration on the selected topic.
- The report and presentation shall be evaluated by a team of internal experts composed of 3 teachers based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the seminar report.

23-204-0819 PROJECT PHASE II

Course Outcomes:

On completion of this course the student will be able to:

1. Realize various steps involved in conducting a project work, like literature survey, the methodology adopted – field study/survey/experiments / numerical work, analysis of the data to arrive at final results and conclusions, etc.
2. Initiate a habit of proper report writing with all of its major components, proper style of writing and preparation of distinct abstract and carved-out conclusions.
3. Conceive the pros and cons of working in a team and the wonderful results which could evolve through teamwork.
4. Present and defend a self-prepared and corrected report (with the help of a project guide) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1			1		1		1	3	3	1	
CO2	3	3	3	3	1			1		1		1	3	3	1	1
CO3	3	3	3	3	1			1		1		1	3	3	1	
CO4	3	3	3	3	1			1		1		1	3	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Instructions

Each batch of students shall develop the project designed during the VII semester. The implementation phase shall proceed as follows:

1. A detailed project report in the prescribed format shall be submitted at the end of the semester. All test results and relevant design and engineering documentation shall be included in the report.
2. The work shall be reviewed and evaluated periodically

A committee consisting of the Project Coordinator (appointed by the Head of the Department / Division), project guide and at least one senior faculty member will carry out the assessment based on at least one interim review and a final review just before the submission of the project report.

The final evaluation of the project shall include the following

1. Presentation of the work
2. Oral examination
3. Demonstration of the project against design specifications
4. Quality and content of the project report.

Guidelines for evaluation:		***Marks***
1.	Regularity and progress of work	20
2.	Work knowledge and Involvement	50
3.	Semester End presentation and oral examination	50
4.	Level of completion and demonstration of Functionality / Specifications	50
5.	Project Report – Presentation style and content	30
	Total	**200**

Note:

Points (1) and (2) are to be evaluated by the respective project guide and the project coordinator based on continuous evaluation. (3)-(5) to be evaluated by the final evaluation team.

23-204-0820 COMPREHENSIVE VIVA VOCE

Course Outcomes:

On completion of this course the student will be able to:

1. Review all the subjects covered during the programme.
2. Gain good knowledge of theory and practice.
3. Develop oral communication skills and a positive attitude.
4. Attend technical interviews with confidence

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2										2	2	1		
CO2	3	2	1	1								1	1	2		
CO3	2	3	2	1	1				1			1	2	1		
CO4	3	2	1									1	2	1		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Instructions

Each student is required to appear for a viva voce examination at the end of the complete course work. The examination panel shall comprise of a minimum of one internal examiner and one external examiner, both appointed by the University. The examiners shall evaluate the students in terms of their conceptual grasp of the course of study and practical/analysis skills in the field.

MINORS IN INFORMATION TECHNOLOGY

23-204-310 FOUNDATIONS OF DATA MANAGEMENT AND STRUCTURES

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals of data and information.
2. Gain proficiency in organizing, storing, and retrieving data.
3. Develop skills in designing and implementing databases.
4. Learn basic algorithms for data processing.
5. Understand and implement fundamental data structures

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1											3			
CO2	3	2	1										3			
CO3		3	3		2								2	3		
CO4	2	2	3		2								2			
CO5	3	2		3	3								2			

1-Slightly**; 2**-Moderately**; 3-**Substantially

Module I

Introduction to Data and Information, Definition of Data and Information, Data Representation. Hierarchy of data models - conceptual, logical, physical, Conceptual data models - ER diagrams. Logical data models - relational schema, Physical data models - internal storage structures. ER diagrams - entities, relationships, attributes.

Module II

Relational Databases: Relational data Model-relations, attributes, tuples, keys, Structure of Relational Databases, Database Schema, Schema Diagrams, Relational Query Languages, Decomposition Using Functional Dependencies, Normalization - 1NF, 2NF, 3NF, BCNF. Data Manipulation and Querying: Basic SQL Querying - DDL, DML statements
Transaction management - ACID properties.

Module III

Introduction to basic Data Structures: Primitive and non-primitive data types, Arrays - 1D, 2D, multidimensional, Linear Arrays: Representation, Inserting, deleting and traversing linear arrays. Searching: Linear search and Binary search in array and their complexity analysis.Lists - singly linked, doubly linked, circular, Stacks and queues

Module IV

Trees - binary trees, Traversing a binary tree: Preorder, Postorder and Inorder traversals. Binary search tree, Inserting, deleting and searching a binary search tree, AVL trees, B and B+ trees, Graphs - directed, undirected, Graph, Graph terminology, Graph representation: Adjacency matrix, Adjacency list, Traversing a graph: DFS, BFS.
Hashing techniques

References:

1. Silberschatz, A., Korth, H.F., & Sudarshan, S. (2019). Database System Concepts (7th ed.). Tata McGraw Hill.
2. Elmasri, R. & Navathe, S.B. (2017). Fundamentals of Database Systems (7th ed.). Addison Wesley.
3. Date, C. J.(2004) . An Introduction to Database Systems (8th ed.). Pearson.
4. Elmasri, R., & Navathe, S. B. (2023). Fundamentals of Database Systems (7th ed.). Pearson.
5. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to Algorithms (3rd ed.). MIT Press.
6. Ullman, J. D., & Widom, J. (2014). A First Course in Database Systems (3rd ed.). Pearson.
7. Carrano, F. M. (2016). Data Structures and Abstractions with Java (4th ed.). Pearson.
8. Sedgewick, R., & Wayne, K. (2011). Algorithms (4th ed.). Addison-Wesley.

23-204-0513 BIG DATA ANALYTICS AND MACHINE LEARNING

Course Outcomes:

On completion of this course the student will be able to:

1. Demonstrate foundational knowledge of big data systems and architecture
2. Apply data wrangling techniques to clean, transform, and normalize large datasets in preparation for analysis.
3. Implement supervised and unsupervised machine learning techniques predictive modeling and knowledge discovery.
4. Evaluate big data analytics models using appropriate validation techniques and performance measures
5. Develop proficiency in using big data tools like Pig, Hive, HBase to perform analysis on large datasets and build big data solutions.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		1	3								2	2		
CO2	1	3	2		3								2	2	1	
CO3			3		3								2	2		1
CO4		1	3	1	3								2	2		
CO5			3		3								2	2		1

1-Slightly**; 2**-Moderately**; 3-**Substantially

Module I

Introduction to Big Data Analytics: Big Data Overview, Key Roles for the New Big Data Ecosystem.
Data Analytics Lifecycle: Overview, Discovery, Data Preparation, Model Planning, Model Building, Communicate Results, Operationalize.
Data Wrangling, Exploring and profiling raw data, Exploratory data analysis to profile and understand raw data,Data cleaning methods
Identifying and handling missing values Detecting and removing outliers, Transforming data (parsing, standardizing, normalizing etc.).

Module II

Machine learning paradigms: supervised, semi-supervised, unsupervised, reinforcement learning. Clustering, Overview of Clustering, K means, Agglomerative. Association Rules: Overview, Apriori Algorithm, Applications of Association Rules, Regression: Linear Regression, Logistic Regression, Validation and Testing

Module III

Classification: Decision Trees, Decision Tree Algorithms, Naïve Bayes, Bayes' Theorem, Diagnostics of Classifiers, Dimensionality reduction: Principal Component Analysis, Basic idea of overfitting. Performance measures: Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC).

Module IV

Understanding Unstructured Data, Introduction to MapReduce Paradigm, Apache Hadoop: Architecture and Components, Architecture of Hadoop Distributed File System (HDFS),Job Tracker and Task Tracker in Hadoop, Fault tolerance mechanisms in Hadoop,
Hadoop Ecosystem, Pig, Hive, HBase, Mahout, NoSQL

References:

1. EMC Education Services. (2015). Data science and big data analytics: Discovering, analyzing, visualizing and presenting data. Wiley.
2. VanderPlas, J. (2016). Python Data Science Handbook. O'Reilly Media.
3. James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). An Introduction to Statistical Learning: With Applications in R (2nd ed.). Springer.
4. Bruce, P., Bruce, A., & Gedeck, P. (2020). Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python (2nd ed.). O'Reilly Media.
5. Géron, A. (2019). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools,

and Techniques to Build Intelligent Systems (2nd ed.). O'Reilly Media. .
6. Nield, T. (2022). Essential Math for Data Science: Take Control of Your Data with Fundamental Linear Algebra, Probability, and Statistics. O'Reilly Media.
7. Gutman, A. J., & Goldmeier, J. (2021). Becoming a Data Head: How to Think, Speak, and Understand Data Science, Statistics, and Machine Learning. Wiley.
8. Irizarry, R. A. (2019). Introduction to Data Science: Data Analysis and Prediction Algorithms with R. Chapman and Hall/CRC.

23-204-0717 MINI PROJECT

Course Outcomes:

On completion of this course the student will be able to:

1. Students will apply core Information Technology principles to devise innovative solutions for interdisciplinary challenges.
2. Students will collaborate effectively in diverse teams, integrating ideas from various disciplines to develop a comprehensive project that addresses both Information Technology principles and the needs of other disciplines.
3. Students will demonstrate proficiency in project management, including planning, resource allocation, and adaptability, ensuring the successful execution of the mini-project within specified constraints.
4. Students will communicate technical concepts clearly through well-structured reports and presentations, demonstrating their ability to convey the significance, methodology, and results of the mini-project.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1			1		1		1	3	3	1	1
CO2	3	3	3	3	1			1		1		1	3	3	1	
CO3	3	3	3	3	1			1		1		1	3	3	1	
CO4	3	3	3	3	1			1		1		1	3	3	1	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Guidelines for Mini Project in Information Technology Minor Course

1. Team Formation: Encourage interdisciplinary teams; Aim for diverse skill sets in each group.
2. Project Proposal: Students propose project ideas aligned with Information Technology principles; The proposal must outline the problem, objectives, and relevance to their disciplines.
3. Project Scope: Clearly define the scope of the project to ensure it aligns with the minor course objectives; Ensure feasibility within the given time and resource constraints.
4. Project Deliverables: Technical Report: Including problem definition, design methodology, analysis, and results; Prototype/Model: If applicable.
5. Presentation: Demonstrating key aspects to the class.
6. Requirements: Integrate concepts from Information Technology into the project; Use relevant software/tools for simulations and analysis.
7. Adhere to safety guidelines; Mentorship: Assign a mentor or allow students to choose one from the Information Technology faculty; Regular check-ins to ensure project progress and offer guidance.
8. Documentation: Emphasize the importance of keeping detailed records of the design process, challenges faced, and solutions implemented.
9. Interdisciplinary Collaboration: Encourage collaboration with students from other disciplines; Assess the extent of integration of ideas from different fields.

Assessment Method

1. Project Proposal Evaluation (10%): Relevance to Information Technology principles; Clear problem definition and objectives.
2. Mid-term Progress Report (20%): Demonstration of progress compared to the initial proposal; Identification and resolution of challenges.
3. Prototype/Model (if applicable) (20%): Functional and realistic representation of the design; Application of Information Technology concepts.
4. Technical Report (30%): Clarity of writing and presentation; Depth of Information Technology concepts applied; Quality of analysis and results.
5. Final Presentation (20%): Ability to communicate technical details to a diverse audience; Handling of questions and feedback.

HONOURS IN INFORMATION TECHNOLOGY

23-204-411 COMPUTATIONAL THINKING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the evolution and importance of CT
2. Apply abstraction, decomposition, algorithmic thinking and pattern recognition in solving real-world problems.
3. Design algorithms for various computing problems.
4. Implement the software solutions to identify and correct bugs.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2											3			
CO2		3											2	3		
CO3		1	3	2									3	3		
CO4			2	3	2								2		3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to CT: Computational Thinking, Computational Methods and Computing Machines; Wishful Thinking; Design Thinking; Definition Computational Thinking; Evolution of CT; Computational thinking for academic disciplines; CT for software systems; CT for science; CT for all.

Module II

Pillars of CT: - Abstraction, Decomposition, Algorithmic Thinking and Pattern Recognition: Information represented in real world: Data Types, Encoding and Decoding, Data structures: Lists, Arrays, Linked Lists, Graphs. Abstraction: Definition of abstraction, layers of abstraction; Representation of abstraction: Class diagrams, Use Case diagrams, Activity Diagrams, State Diagrams. Decomposition: Definition of decomposition, decomposition in software design, other uses of decomposition, functions and modularity.
Algorithms: Problem Definition, Logical Reasoning, Types of Logics, Applications of Logic; Data representations, Flowcharts, Flow control, conditional logics, Loops. Pattern Recognition: Identify and create patterns, use cases.

Module III

Simulations and Use Cases using Python: Hand simulation of a small program (squaring an integer), Iterative and recursive implementations (factorial), rabbit population (Fibonacci series), Palindromes; Searching (linear and binary search) and Sorting (selection and merge sort); Lists and Dictionaries; Monte Carlo simulation: Pascal's Problem and Pass or Don't Pass.

Module IV

Error Handling: Computer Error and its types; Software Correctness: Validation and Verification; Software testing (black box and white box testing); Programs with bugs; Exception handling.
Other forms of CT: Plugged and Unplugged approaches (Code.org, MIT Scratch Programming, Google Blockly, MIT App Inventor).

References :

1. Denning, P. J., & Tedre, M. (2019). Computational Thinking. MIT Press. ISBN: 0262536560.
2. Riley, D., & Hunt, K. A. (2014). Computational Thinking for the Modern Problem Solver (Chapman & Hall/CRC Textbooks in Computing). ISBN: 1466587776.
3. Guttag, J. V. (2021). Introduction to Computation and Programming Using Python (Third Edition). ISBN: 0262045788

23-204-514 RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize and articulate meaningful research problems
2. Analyse solutions for research problems, encompassing data collection, analysis, interpretation, and the use of necessary instrumentation.
3. Develop effective literature review skills, acquired knowledge about research ethics and plagiarism, and enhanced their technical writing abilities.
4. Comprehend the nature of intellectual property, including patents, industrial designs, trademarks, and copyrights.
5. Gain insights into international cooperation on intellectual property, including the procedure for granting patents.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2										2			
CO2	3	2	3										2			
CO3	3	3	3										2			
CO4	1			3	3			3	2	2			2			
CO5	1			3	3			2	2	1			2			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches to investigation of solutions for research problem - data collection, analysis, interpretation. Necessary instrumentation.

Module II

Effective literature review approaches, Plagiarism, Research ethics.

Effective technical writing. How to write a good report and a paper?

Developing a Research Proposal, Format of research proposal, Presentation and assessment by a review committee.

Module III

Nature of Intellectual Property: Patents, Industrial Designs, Trademark and Copyright.

Process of Patenting and Development: technological research, innovation, patenting, development.

International Scenario: International cooperation on Intellectual Property. Procedure for grant of patents, Patenting under Patent Cooperation Treaty (PCT).

.

Module IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indication of goods. New Developments in IPR: Administration of Patent System. IPR of Biological Systems, Computer Software etc. Traditional knowledge: Indigenous, medicinal and bioprospecting knowledge, Need for protection.

References:

1. Melville, S., & Goddard, W. (1996). Research methodology: An introduction for Science & Engineering students. Juta & Co Ltd.
2. Kumar, R. (2022). Research Methodology: A Step by Step Guide for beginners (6nd ed.). Pearson.
3. Gopalakrishnan, N. S., & Agitha, T. G. (2015). Principles of Intellectual Property (2nd ed.). Eastern Book Company.
4. Bansal, K., & Bansal, P. (2013). Fundamentals of Intellectual Property for Engineers. BS Publications.
5. Bouchoux, D. E. (2022). Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets (6th ed.). Cengage Learning.
6. Markel, M. (2022). Technical Communication (13th ed.). Mac Millan.

23-204-613 OPTIMIZATION TECHNIQUES

Course Outcomes:

On completion of this course the student will be able to:

1. Understanding the Concept of optimization and classification of optimization problems.
2. Formulation simplex methods variable with upper bounds
3. Study the Queuing Model, poisson and exponential distributions
4. Understand the maximization and minimization of convex functions
5. Study equality constraints, inequality constraints.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2		2									2			
CO2	3	3		3									2			
CO3	3		3										2			
CO4		3		3									2			
CO5					3								2			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Concept of optimization – classification of optimization – problems.

Linear programming - Examples of linear programming problems – formulation simplex methods variable with upper bounds – principle duality -dual simplex method - sensitivity analysis – revised simplex procedure – solution of the transportation problem – assignment – network minimization – shortest route problem – maximal two problem – L.P. representation of networks.

Module II

Queuing theory - Queuing Model, poisson and exponential distributions -Queues with combined arrivals and departures-random and series queues

Module III

Unconstrained optimization - Maximization and minimization of convex functions. Necessary and sufficient conditions for local minima – speed and order of convergence – univariate search – steepest and descent methods-metcher reeves' method -conjugate gradient method.

Module IV

Constrained optimization - Necessary and sufficient condition – equality constraints, inequality constraints -kuhn – tucker conditions – gradient projection method – penalty function methods – cutting plane methods of sibel directions.

Non-linear problems - Non-linear constrained optimization models, KKT conditions, Projection methods

References :

1. Rao, S. S. (2019). Engineering Optimization: Theory and Practice, 5th Edition. Wiley.
2. Luenberger, D. G., & Ye, Y. (2016). Linear and Nonlinear Programming (4th ed.). Springer.
3. Beveridge, G. S. G., & Schechter, R. S. (1970). Optimization: Theory and Practice. McGraw-Hill.
4. Taha, H. A. (2017). Operations Research: An Introduction (10th ed.). Pearson.
5. Beightler, C. S., Phillips, D. T., & Wilde, D. J. (1994). Foundations of Optimization (2nd ed.). Prentice-Hall

*****