Department of Civil Engineering
Draft syllabus for 5th semester

COURSE STRUCTURE

5th Semester /3rd Year							
Name of the Programme		**B.Tech in Civil Engineering**					
Name of the Department		**Civil Engineering**					
A.		**Theory Courses**					
Sl No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**Coordinating Department**
1	UHS501	Industrial Management and Entrepreneurship	3	0	0	3	HSS
2	UCE501	Structural Analysis-II	3	0	0	3	CE
3	UCE502	Environmental Engineering-I	3	0	0	3	CE
4	UCE503	Transportation Engineering-II	3	0	0	3	CE
5	UCE504	Hydrology & Water Resources Engineering	2	1	0	3	CE
6	UCE51*	Elective-I	3	0	0	3	CE
7	UCE511	Industrial Wastewater Management					
8	UCE512	Water Supply and Sanitary Installation					
Total of A			**17**	**1**	**0**	**18**	
B.		**Laboratory/Project/Seminar Courses**					
Sl No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**Coordinating Department**
1	UCE571	Environmental Engineering-I Lab	0	0	2	1	CE
2	UCE572	Transportation Engineering Lab	0	0	2	1	CE
Total of B			**0**	**0**	**4**	**2**	
C.		**Audit/Non-credit Courses**					
Sl No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**Coordinating Department**
Total of C							
Grand Total (A+B+C)			**17**	**1**	**4**	**20**	

Course Code:	UHS501
Course Title:	Industrial Management and Entrepreneurship
Course Credit:	03
L-T-P:	3-0-0
Total Contact Hours:	36

Course objective:	The primary objective of this course is to provide engineering students with a broad understanding of management and entrepreneurial principles, equipping them to excel in managerial roles or to start and manage their own ventures. The Course Objectives for Industrial Management and Entrepreneurship are: • To gain knowledge of core management concepts, principles, and practices. • To develop skills in managing operations, including production planning, scheduling, and quality control. • To formulate and implement strategies for achieving organizational goals. • To understand the role of motivation, communication, and conflict resolution in managing teams. • To study different types of entrepreneurships, including social and corporate entrepreneurship. • To learn techniques for identifying and developing innovative business ideas. • To explore methods for market research and validation of business concepts.
Pre-requisites:	Codes of the courses which may be listed as pre-requisites for this course (preferably from the earlier semester's curricula of the programme).
Course outcomes:	After Completion of this course students will be able to: 1. Apply Management Theories: Demonstrate the ability to apply core management theories and principles to industrial scenarios, effectively addressing organizational and operational challenges. 2. Manage Resources Effectively: Develop strategies for the optimal management and allocation of resources, including human, material, and financial resources, to achieve organizational goals 3. Develop Viable Business Ideas: Generate and evaluate innovative business ideas, using market research and feasibility analysis to validate potential opportunities. 4. Implement Effective Marketing Strategies: Design and execute marketing and sales strategies to build brand awareness, attract customers and achieve market positioning.

	5. Manage Start-up Operations: Demonstrate the ability to manage the day-to-day operations of a start-up, including handling team dynamics, scaling operations and managing growth effectively.

Unit/ Module no.	**Topic**	**Nos. of contact hours**
1	Meaning and Concept of Management, Principles and function of Management, Concept and scope of Organizational Behavior, Function of a Manager—Planning, Organizing, Coordinating and Controlling, Motivation—implication of Managers and application. Leadership, Qualities and Styles of Leadership, Decision making process.	8
2	Individual Process in Organizations- Personality, Perception, and Attitude, Factors that affect them, How they influence people. Organizational Conflicts and Conflict Management, SWOT Analysis: Meaning and Significance, Job Satisfaction and Job Dis-Satisfaction: Meaning and Effect, Concept of Stress Management and Time Management	10
3	Evolution, Role and Status of Human Resource Management in India. Recruitment and Selection Process in Organization- Job Analysis-Job Specification-Selection Process-Test and Interview. Trade Union and Collective Bargaining.	8
4	Entrepreneurship-Meaning, Types of entrepreneur, Qualities of an entrepreneur, Role of Entrepreneur, Factors affecting entrepreneurial growth. Entrepreneurship Development Programme-Concept, Objective and Importance, Modern Marketing Tools for Entrepreneurs, Business Idea: Meaning and Factors affecting generation of Business Idea, Concept of Creativity and Innovation for Startups. Business Opportunity Analysis.	8
5	Small Scale Industry-Definition, Types of Small-Scale Industry, How to Set up Small Scale Industry, Role and Problem of Small-Scale Industry, Concept of Joint Stock Company, Private and Public Limited Company, Meaning of IPR, Legal and Ethical Issues of the Entrepreneur	8

Textbooks:

1. Khanka, S. S (2023), New-Delhi, Organisational Behaviour, S.Chand& Company
2. Sarkar, S.S., Sharma, R.K. and Gupta, S.K. (2021), New-Delhi, Business Organisation and Entrepreneurship Development, Kalyani Publishers
3. Debnath, Arabinda (2015), Guwahati, Principles of Management, BLG Publication
4. Prasad, L.M. (2020), New-Delhi, Principles and Practice of Management, S. Chand& Company
5. Khanka, S. S. (2020), New Delhi, Entrepreneurial Development, S. Chand& Company
6. Debnath, Arabinda (2018), New Delhi, Industrial Management and Entrepreneurship, Kalyani Publishers

References:

1. Shukla, M.B. (2015), Guwahati, Entrepreneurship and Small Business Management, KitabMahal.
2. Bhatia, Kanchan and Mittal, Shweta (2016), New-Delhi, Management Concept and Practice, Variety Books Publishers & Distributors

Course Code:	UCE501
Course Title:	Structural Analysis-II
Course Credit:	03
L-T-P:	3-0-0
Total Contact Hours:	36

Course Objectives:	The objectives of this course are: • To provide advanced knowledge of analyzing statically indeterminate structures using classical and modern methods. • To study the analysis of continuous beams, frames, and arches for bending moments, shear, and axial forces. • To develop an understanding of slope-deflection, moment distribution, and Kani's methods for indeterminate structures. • To enhance problem-solving skills using numerical methods and computer software for structural analysis.
Pre-requisites:	Basic knowledge of structural analysis, strength of materials, engineering mechanics, engineering mathematics.
Course Outcomes:	After completion of this course students will be able to: 1. Explain the concepts of indeterminate structures and the necessity of advanced analysis method 2. Computation of degrees of freedom 3. Analyse continuous beams and frames using slope-deflection, moment distribution methods and Kani's Method

Module No.	Topic	Nos. of contact hours
1	**Introduction:** Indeterminate structures, Static and Kinetic indeterminacy and their calculation.	4
2	**Indeterminate Beams:** Propped cantilever, Fixed Beam, Continuous beams, sinking of support, temperature effect, and three moment equation.	10
3	**Classical Displacement Method:** Slope deflection method, Moment distribution method, Kani's Method – application to analysis of indeterminate Beams and Building frames.	11

4	**Classical Force Method:** Trusses and rigid frames by consistent deformation method Column analogy method and elastic centre method. Masonry Dams and Retaining Walls, Condition for No tension. Chimneys, piers and Abutments. Introduction to Fatigue, creep and stress Concentration.	11

Textbooks:

1. Basic Structural Mechanics by C.S. Reddy, Tata Mc. Grew Hill.
2. Indeterminate Structural Analysis by C.K. Wang, Tata Mc. Grew Hill.
3. Theory of Structures by G.S. Pundit, S.P. Gupta & R. Gupta, Tata Mc. Grew Hil.l
4. Analysis of Structures Vol. – I &II, by V.N. Vazirani & M.M. Ratwani, Khanna Pub.

References:

1. Indeterminate Structural Analysis by J. Sterling Kinney
2. Structural Analysis of Indeterminate Structures: Volume 1 – Theory, Concepts, and Methods in Civil Engineering

Course Code:	UCE 502
Course Title:	Environmental Engineering-I
Course Credit:	3
L-T-P:	3-0-0
Total contact hours:	36

Course objectives:	The course is designed to achieve the following objectives: • To introduce the sources, types and impact of environmental pollution on ecosystem and human health. • To impart fundamental knowledge and practical skills related to planning, design, construction and maintenance of water supply system • To equip students with the ability to understand water sources, estimate water demand, need of water quality analysis • To understand important components of water supply lines • To develop an understanding of treatment processes and efficient distribution systems • To equip students with basic skills to identify environmental problems -sources-effects and apply appropriate strategies-prevention- controlling measures and its legislative aspects.
Pre-requisites:	Nill
Course outcome:	After completion of this course students will be able to: 1. Identify the sources of water supply and estimate the quantity of water required to meet various water demands at the end of design period, design and lay raw water transmission mains. 2. Demonstrate understanding of water quality parameters and standards. 3. Understands and explain the processes involve in the collection, treatment, and distribution of water 4. Design treatment units to remove suspended solids. 5. Design filter and suggest alternative methods for chlorination, water softening, defluorination and desalination. 6. Determine the storage capacity of distribution reservoir and analyse complex distribution networks using Hardy Cross method.

	7. Identify the types and sources of pollution and its effects and explain controlling measures and preventing strategies for different types of pollution.

Module no.	Topic	Nos. of contact hours
1	**Introduction to Environmental Engineering:** General outline of water supply; sources of water supply, Necessary and objectives of public water supply schemes– planning and financing, Water Demand: Concept of water demand; Estimation of water demand; Factors affecting demand; Components of demand; Demand fluctuations; Demand design periods, population growth and forecast, quantification of water demand through population forecasting.	4
2	**Quality of water and Conveyance of water:** Quality of water, portable water, pure water, mineral water, drinking water standards - Physical, chemical, and biological analysis. Conveyances of water: types, pipe corrosion, and remedial measures.	6
3	**Water treatment and purification process:** Water treatment plant: layout plan, estimation of raw water discharge for treatment plant, treatment of water- Screening, Aeration, Sedimentation: plain sedimentation, sedimentation with coagulation, design of settling tank, Filtration: types of filters, design of filter, Disinfection, Advanced water treatment.	14
4	**Water Distribution and Supply:** Requirements and Layout of water distribution network- Methods of distribution-Analysis of distribution networks- Hardy cross method, Appurtenances: Leak detection. Principles of design of water supply in buildings, House service connection — Fixtures and fittings, plumbing and types of plumbing.	6

6	**Environmental Pollution and controlling measures:** Pollution (air, water, noise)- Basic concept, measurement, and various control methods, Solid waste management-Municipal solid waste, Composition, characteristics (chemical and physical parameters) of MSW, MSW management: Collection, transport, treatment, and disposal of MSW. Impacts of MSW on environment.	6

Textbooks:

1. Water Supply Engineering, S.K. Garg, 34 th Edition, Khanna Publishers, Delhi, 2022.
2. Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khanna Publications, Delhi, 2009.
3. Water Supply Engineering, B.C Punmia, "Laxmi Publications Pvt. Ltd., 2016

References:

1. Water Supply &Sanitary Engineering, G.S. Birdi and J.S.Bindie, Dhanpat Rai Publishing Co., New Delhi,1998.
2. Water Supply Engineering (Environmental Engineering Vol. I): P.N. Modi Standard Book House, New Delhi, 2010.
3. Environmental Engineering, Peavy, Tachobanoglous & Rowe, McGraw Hill International, N.Y.,1985
4. Wastewater Engineering: Treatment, Disposal and Reuse, Metcalf & Eddy, Tata McGraw Hill, New Delhi, 2003
5. Water Supply Engineering, Subhash Verma, Varinder Kanwar, Siby John, Vikash Publishing, 2015
6. Elements of Environmental Engineering, K N Dugal, S Chand and Company Pvt Ltd, 2007
7. Introduction to Environmental Engineering, Mackenzie L Davis, McGraw hill Education (India), 2012
8. Environmental Engineering, P Venugopala Rao, PHI Learning Pvt Ltd, 2002
9. APHA, Standard Methods Examination of Water and Wastewater, American Public Health Association, Washington DC, 2017
10. Municipal Solid Waste Management Manual, Central Public Health, and Environmental Engineering Organisation (CPHEED) 2016

Course Code:	UCE503
Course Title:	Transportation Engineering-II
Course Credit:	03
L-T-P:	3-0-0
Contact Hours:	36

Course objective:	The objectives of this course are: • To analyze and design the geometric elements and infrastructure components of railway systems. • To plan and design the layout, runways, and essential facilities for airports. • To understand the planning, design, and operational principles of docks and harbors, including their protective structures. • To describe and evaluate various tunneling methods, construction techniques, and safety requirements for different ground conditions. • To introduce the fundamental components and technologies constituting modern Intelligent Transport Systems (ITS).
Pre-requisites:	Basic knowledge of surveying and Highway Engineering
Course outcomes:	After completion of this course students will be able to 1. Analyze and geometrically design all components of permanent railway track structures. 2. Plan and design the layout and functional components of airports. 3. Decide various protective structures required for docks and harbors. 4. Evaluate and select suitable methods for tunnel excavation, lining, and ventilation. 5. Apply ITS technologies for effective traffic management and safe transportation planning.

Module no.	**Topic**	**Nos. of contact hours**
1.	**Traffic Engineering:** Road user, vehicle and traffic characteristics – Speed, volume, parking and accident studies. Concepts of PCU,	8

	capacity and level of service. Traffic signs and road markings - objectives, classification and uses. Principles of design of at-grade intersections –channelized, rotary and signal intersections, Grade separated intersections	
2.	**Railway Planning:** Comparison of Road, Rail, Air and Water transports – Elements of permanent way – Rails, Sleepers, Ballast, rail fixtures and fastenings, – Track Stress, coning of wheels, creep in rails, defects in rails – Route alignment surveys – Geometric design of railways, gradient, super elevation, widening of gauge on curves- Points and Crossings.	10
3.	**Railway Construction and Maintenance:** Earthwork – Stabilization of track on poor soil, Calculation of Materials required for track laying – Construction and maintenance of tracks – Modern methods of construction & maintenance	4
4.	**Airport Planning and Design:** Airport classification, airport planning: objectives, components, layout characteristics, and socioeconomic characteristics of the catchment area, criteria for airport site selection and ICAO stipulations, typical airport layouts, Parking and circulation area. Runway Design: Orientation, Wind Rose Diagram, Runway length, Problems on basic and Actual Length, Geometric design of runways, Configuration and Pavement Design Principles, Elements of Taxiway Design, Airport Zones, Passenger Facilities and Services, Runway and Taxiway Markings and lighting.	6
5.	**Harbour, Dock and Tunnel Engineering:** Definition of Basic Terms: Planning and Design of Harbours: Requirements, Classification, Location and Design Principles – Harbour Layout and Terminal Facilities. Harbor docks, Wet docks, Repair docks, Lift docks, Floating docks, Slipways. Introduction, size and shape of the tunnel, tunneling methods in soils, tunnel lining, tunnel drainage and ventilation.	4
6.	**Intelligent Transportation Systems:** Introduction, Data collection techniques, Telecommunications in ITS, ITS functional areas, ITS User Needs and Services.	4

Textbooks:

1. Veeraragavan. A, Khanna. K and Justo. C.E.G. Highway Engineering, Nem Chand & Bros Publishers.
2. Railway Engineering, Satish Chandra and M.M. Agarwal, second Edition, Oxford University Press, New Delhi.

3. Airport Planning and Design, S. K. Khanna, M. G. Arora and S. S. Jain, Nemchand and Brothers, Roorkee.
4. Transportation Engineering, Volume II: Railways, Airports, Docks and Harbours, Bridges and Tunnels, C Venkatramaiah, Universities Press.

References:

1. Partha Chakroborty and Animesh Das Principles of Transportation Engineering, PHI Learning Pvt. Ltd.
2. Airport Planning and Design, S. K. Khanna, M. G. Arora and S. S. Jain, Nemchand and Brothers, Roorkee.
3. R. Srinivasa Kumar., Textbook of Highway Engineering, Universities Press (India).
4. Subhash C Saxena, Textbook of Highway and Traffic Engineering. CBS Publishers.
5. Kadiyali. L. R. Principles and Practice of Highway Engineering, Khanna Technical Publications, Delhi.
6. M A Chowdhary and A Sadek. Fundamentals of Intelligent Transportation systems planning. Artech House Inc., US.
7. Subramanian K.P., Highways, Railways, Airport and Harbour Engineering, Scitech Publications (India)

Course Code:	UCE504
Course Title:	Hydrology & Water Resources Engineering
Course Credit:	03
L-T-P:	2-1-0
Total Contact Hours:	36

Course objective:	The objective of this course is to impart knowledge on: • importance of hydrology and hydraulics in sustainable harnessing of water resources, • hydrological theories and techniques for data collection, compilation and analysis, water availability assessment, flood estimation, and groundwater flow estimation, • basic hydraulic theories and techniques for planning and design of hydraulic structures.
Pre-requisites:	Basic knowledge of fluid Mechanics and environmental science
Course outcomes:	After completion of this course students will be able to 1. know the techniques of collecting data of hydrological processes, and carry out quality checks, 2. understand and apply hydrologic principles and techniques to assess water availability for engineering projects, estimate flood, estimate groundwater flow in aquifers, 3. understand the types and applications of various hydraulic structures, such as dams, weirs and barrages, river training works, cross drainage works, and canal components.

Module no.	Topic	Nos. of contact hours
1	**Introduction:** Hydrology and its applications in civil engineering; Hydrologic cycle and water-budget equation; Consumptive and conjunctive use of water; Environmental Flow.	3
2	**Precipitation and abstraction from precipitation:** Precipitation characteristics and its impact on water-availability, safety and economy; Methods of measuring and/or estimating precipitation and abstractions from precipitation, Sources of data; Data quality-checking and analysis; Return period and its use, Probable Maximum Precipitation (PMP) and Standard Project Storm (SPS).	9
3	**Surface water use and water-availability assessment:** Measurement and/or estimation of flow and flow-volumes in channels; Factors affecting runoff and hydrograph; Reservoir capacity	8

	estimation; Flow-Duration Curve; Unit Hydrograph; Droughts; Water harvesting; Natural & artificial groundwater recharge methods.	
4	**Flood estimation, forecasting and control:** Methods of flood estimation; Central Water Commission's Flood Estimation Reports; River training and flood control methods and structures.	4
5	**Ground water resource assessment:** Occurrence and movement of groundwater; Aquifers and aquifer characteristics; Steady and unsteady groundwater flow; Ground water flow equations; Well hydraulics (for steady flow)	3
6	**Water retaining and diversion structures:** Reservoir and reservoir site selection criteria; Dams, weirs and barrages; Criteria of dam selection; Forces acting on dams; Modes of failure of dams; Spillways and energy dissipation arrangements.	4
7	**Water distribution structures:** Canal systems and alignments; Estimation of design discharge of canals; Cross drainage works; Criteria for design of rigid and mobile boundary channels; Canal water loss and canal lining; Economic section of canal	3
8	**Hydro power development structures:** Hydroelectric power and energy assessment; Types of hydropower projects; Hydraulic structures of hydropower projects; Turbines and their characteristics.	2

Textbooks:

1. Subramanyam, K., Engineering Hydrology, 6th ed. (2024), Tata McGraw Hill, New Delhi.
2. Garg, S.K. (Irrigation Engineering and Hydraulic structures, Khanna Publishers, 38th ed., Khanna Publishers, ISBN-10 : 8174090479, ISBN-13 : 978-8174090478, 1132 pages.

References:

1. Todd, D.K., Groundwater Hydrology, 1993 John Wiley & Sons.
2. Garg, S.K., Hydrology and Water Resources Engineering.
3. Raghunath, H.M., Hydrology – Principles, Analysis and Design, 1986, Wiley.
4. Raghunath, H.M., Groundwater, 1987, Wiley Eastern Ltd., New Delhi.
5. Modi, P.N., Irrigation Water Resources and Water Power Engineering, Standard Book House.
6. https://cwc.gov.in/ . Homepage of Central Water Commission (Refer to the Publications section)
7. https://cgwb.gov.in/cgwbpnm/ . Publications Repository of Central Ground Water Board
8. https://www.imdpune.gov.in/lrfindex.php. Homepage of Climate Research & Services, India Meteorological Department, Pune (Refer to Climate Monitoring section)
9. http://cpheeo.gov.in/cms/national-mission-on-sustainable-habitat.php# . Homepage of Central Public Health & Environmental Engineering Organization (CPHEEO) (Refer to CPHEEO Manuals section)

Elective-I

Course Code:	UCE511
Course Title:	Industrial Wastewater Management
Course Credit:	3
L-T-P	3-0-0
Total Contact Hours	36

Course objective:	The objective of this course is to impart knowledge on: • Distinguish between the quality of domestic and industrial water requirements and Wastewater quantity generation • Understand the industrial process, water utilization and waste water generation • Impart knowledge on selection of treatment methods for industrial wastewater • Acquire the knowledge on operational problems of common effluent treatment plants. • Gain knowledge on different techniques and approaches for minimizing the generation and application of Physio chemical and biological treatment methods for recovery, reuse and disposal of industrial wastewater.
Pre-requisites:	Basic knowledge of Environmental Engineering
Course outcomes:	After completion of this course students will be able to: 1. Define and reason about fundamental concepts of waste water treatment 2. Design and conduct experiments and the ability to analyse the data, interpret results and draw conclusions. 3. Think logically, critically and creatively and will be able to Identify, formulate and solve civil engineering problems.

Module no.	**Topic**	**Nos. of contact hours**
1	**Sources of Pollution:** Physical, Chemical, Organic & Biological properties of Industrial Wastes - Difference between industrial & municipal waste waters - Effects of industrial effluents on sewers and Natural water Bodies.	6
2	**Pre & Primary Treatment:** Equalization, Proportioning, Neutralization, Oil separation by Floating-Waste Reduction-Volume Reduction-Strength Reduction.	7
3	**Waste Treatment Methods:**	7

	Nitrification and De-nitrification-Phosphorous removal -Heavy metal removal - Membrane Separation Process - Disposal of Treated Waste Water.	
4	**Wastewater Characteristics and Composition I:** Characteristics and Composition of waste water and Manufacturing Processes of Industries like Sugar, Characteristics and Composition of Industries like Food processing Industries, Steel, and Petroleum Refineries.	8
5	**Wastewater Characteristics and Composition II:** Characteristics and Composition of Industries like Textiles, Tanneries, Atomic Energy Plants and other Mineral Processing Industries – Joint Treatment of Raw Industries waste water and Domestic Sewage – Common Effluent Treatment Plants (CETP) – Location, Design, Operation and Maintenance Problems – Economical aspects.	8

Textbooks:

1. Metcalf & Eddy, "Wastewater engineering Treatment disposal reuse", Tata McGraw Hill.
2. Eckenfelder, W.W., "Industrial Water Pollution Control", McGraw-Hill

References:

1. M.N. Rao and Dutta – Industrial Waste.
2. Mark J. Hammer, Mark J. Hammer, Jr., "Water & Wastewater Technology", Prentice Hall of India.
3. N.L. Nemerrow –Theories and practices of Industrial Waste Engineering.
4. C.G. Gurnham –Principles of Industrial Waste Engineering.

Course Code:	UCE512
Course Title:	Water Supply and Sanitary Installation
Course Credit:	3
L-T-P:	3-0-0
Total Contact Hours:	36

Course objective:	The objective of this course is to impart knowledge on: • Importance of Codes, Architectural and Structural Coordination • Architectural and Structural coordination • Plumbing Terminology, Plumbing Fixtures and Fittings • Traps, Interceptors, Indirect Waste and Vents • Sanitary Drainage and Storm Drain
Pre-requisites:	
Course outcomes:	At the end of the course, the students are able to: 1. Study plumbing codes and good engineering practices. 2. Coordinate plumbing works from inception to completion with Owners, Architects, other consultants and contractors. 3. Select proper plumbing materials and systems. 4. Read and interpret plumbing drawings. 5. Supervise code based plumbing installations. 6. Understand methods to conserve water and energy. 7. Protect health and safety of end users. 8. Enjoy better job opportunities and career options.

Module no.	Topic	Nos. of contact hours
1	**Importance of Codes, Architectural and Structural Coordination:** Codes and Standards in the building industry, UIPC-I, NBC and other codes, Local Municipal Laws, approvals, general regulations, standards, water supply, sewerage system, drainage system, workmanship, water conservation, protection of pipes and structures, waterproofing.	8

	Architectural and Structural coordination: Provisions for plumbing systems, coordination, space planning for plumbing systems.	
2	**Plumbing Terminology** Definitions, use/purpose of the following. Plumbing Fixtures, Traps: Drainage: Water supply	7
3	**Plumbing Fixtures and Fittings** Definitions of plumbing fixtures, fittings, appliances and appurtenances; maximum flow rates, water closets, bidets, urinals, flushing devices, washbasins, bath/shower, toilets for differently abled.	7
4	**Traps, Interceptors, Indirect Waste and Vents** Traps required, trap arms, developed length, trap seals,venting to traps, trap primers, prohibited traps, building traps. Discharge for indirect waste piping, nature of contents orsystems. Vent requirement, purpose of venting, trap seal protection, materials, vent connections, flood rim level, termination, vent stacks, water curtain and hydraulic jump, cleanouts, venting of interceptors, introduction to vent sizing.	7
5	**Sanitary Drainage and Storm Drain** Preamble, one pipe and two pipe systems, different pipe materials and jointing methods, special joints, hydraulic jump, change in direction of flow, T and Y fittings, introduction to Drainage Fixture Units (DFU) and sizing of horizontal and vertical pipes. Storm drain required, prohibited connections, subsoil drains, sub-drains, gutters, channels, sizing case study as per NBC, safety, traps required, prohibited installations. Rain Water Harvesting (RWH), NBC requirements, MOEF&CC requirements, and advantages of RWH.	7

Textbooks:

1. Uniform Illustrated Plumbing Code-India (UIPC-I) published by IPA and IAPMO(India)
2. National Building Code (NBC) of India
3. IS 17650 Part 1 and Part 2 for Water Efficient Plumbing Products

References:

1. Water Efficient Products-India (WEP-I) published by IPA and IAPMO (India)
2. Water Efficiency and Sanitation Standard (WE.Stand) published by IPA and IAPMO(India)
3. Water Pollution, Berry, CBS Publishers.
4. ‘A Guide to Good Plumbing Practices’, a book published by IPA.
5. Elements of Water Pollution Control Engineering, O.P. Gupta, Khanna Book Publishing, New Delhi.

Laboratory Courses

Course Code:	UCE 571
Course Title:	Environmental Engineering-I Laboratory
Course Credit:	01
L-T-P:	0-0-2
Total Contact Hours:	24

Course objective:	The objectives of this course are: • To familiarize students with water and sampling techniques • To determine key water quality parameters • To gain hands on experience with laboratory instruments and analytical techniques • To understand the importance of test result in assessing environmental quality and to correlate the laboratory finds
Pre-requisites:	NIL
Course outcomes:	After completion of this course students will be able to: 1. Perform sampling and testing of water sample 2. Determine and interpret key water quality parameters 3. Demonstrate proper use and calibration of instruments 4. Interpret test result as per relevant standards

Module No.	**Experiment**	**Nos. of contact hour**
1	Introduction to standards, collection and preservation of samples, sampling techniques and laboratory equipments.	24
2	Experiment on determination of total dissolved and suspended solids in water.	
3	Experiment on determination of pH.	
4	Experiment on determination of conductivity.	
5	Experiment on determination of chlorides.	
6	Experiment on determination of turbidity and jar test.	

7	Experiment on determination of acidity of water.	
8	Experiment on determination of alkalinity of water.	
9	Experiment on determination of total hardness.	
10	Experiment on determination of residual chlorine.	
11	Experiment on determination of DO, BOD, COD.	
12	Bacteriological quality measurement: MPN.	
13	Ambient Air quality monitoring (TSP, RSPM, SOx, NOx) Ambient noise measurement.	

Textbooks:

1. Water Supply Engineering, S.K. Garg, Khanna Publications, Delhi, 2009.
2. Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khanna Publications, Delhi, 2009.
3. APHA, Standard Methods Examination of Water and Wastewater, American Public Health Association, Washington DC, 2017.
4. Municipal Solid Waste Management Manual, Central Public Health and Environmental Engineering Organization (CPHEED) 2016

References:

1. Water Supply &Sanitary Engineering, G.S. Birdi and J.S.Bindie, Dhanpat Rai Publishing Co., New Delhi,1998.
2. Water Supply Engineering (Environmental Engineering Vol. I): P.N. Modi Standard Book House, New Delhi, 2010.
3. Environmental Engineering, Peavy, Tachobanoglous & Rowe, McGraw Hill International, N.Y.,1985.
4. Wastewater Engineering: Treatment, Disposal and Reuse, Metcalf & Eddy, Tata McGraw Hill, New Delhi, 2003.
5. Water Supply Engineering, Subhash Verma, Varinder Kanwar, Siby John, Vikash Publishing, 2015.
6. Elements of Environmental Engineering, K N Dugal, S Chand and Company Pvt Ltd, 2007
7. Introduction to Environmental Engineering, Mackenzie L Davis, McGraw hill Education (India), 2012.
8. Water Supply Engineering, B.C Punmia, “Laxmi Publications Pvt. Ltd., 2016
9. Environmental Engineering, P Venugopala Rao, PHI Learning Pvt Ltd, 2002

Course Code:	UCE572
Course Title:	Transportation Engineering Lab
Course Credit:	1
L-T-P:	0-0-2
Contact Hours:	24

Course objective:	• To conduct standard tests to determine the mechanical strength properties of road aggregates. • To determine the physical and geometrical properties of aggregates for pavement construction. • To measure the various rheological properties (consistency, temperature susceptibility) of bituminous binders. • To evaluate the strength of subgrade soil for pavement design using the CBR test. • To design and analyze bituminous mixes using the Marshall Stability method.
Pre-requisites:	Basics of Highway Engineering
Course outcomes:	After completion of this course students will be able to 1. Determine the crushing, impact, and abrasion resistance of aggregates. 2. Evaluate the shape, size, specific gravity, and water absorption of aggregates. 3. Characterize bitumen by its penetration, ductility, softening, and flash point. 4. Perform the California Bearing Ratio (CBR) test for subgrade evaluation. 5. Calculate the optimum binder content and stability of a bituminous mix.

Module no.	**Topic**	**Nos. of contact hours**

1	Determination of aggregate crushing value.	24
2	Determination of aggregate impact value.	
3	Determination of aggregate abrasion value.	
4	Determination of flakiness index and elongation index of aggregates.	
5	Determination of specific gravity and water absorption test on aggregates.	
6	Determination of CBR value.	
7	Determination of specific gravity of Bitumen.	
8	Determination of penetration value of Bitumen.	
9	Determination of ductility value of Bitumen.	
10	Determination of softening point of Bitumen.	
11	Determination of flash and fire point of Bitumen.	
12	Determination of viscosity value of Bitumen	
13	Marshall Stability test.	
14	Traffic studies	

Textbooks:

1. Veeraragavan. A, Khanna. K and Justo. C.E.G. Highway Engineering, Nem Chand & Bros Publishers.
2. Khanna.S. K., Justo. C. E. G and Veeraragavan A. "Highway Materials and Pavement Testing", Nem Chand and Bros., Roorkee.

References:

1. Kadiyali. L. R. Principles and Practice of Highway Engineering, Khanna Technical Publications, Delhi.
2. Sharma. S. K Principles, Practices and Design of Highway Engineering, S. Chand and Company Ltd.
3. R. Srinivasa Kumar., Textbook of Highway Engineering, Universities Press
4. Subhash C Saxena, Textbook of Highway and Traffic Engineering. CBS Publishers.
5. C. Venkatramaiah., Transportation Engineering-Highway Engineering, Universities Press

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Dept. of CSE, UG, New Syllabus

Semester V

Sl. No	Code No.	Course Title	L	T	P	Credits
1.	UCS501	Computer Networks	3	0	0	3
2.	UCS571	Computer Networks - Lab	0	0	2	1
3.	UCS502	Machine Learning	3	1	0	4
4.	UCS572	Machine Learning - Lab	0	0	2	1
5.	UCS503	Introduction to Database Systems	3	0	0	3
6.	UCS573	Introduction to Database Systems - Lab	0	0	2	1
7.	UCS504	Operating Systems	3	0	0	3
8.	UCS574	Operating Systems - Lab	0	0	2	1
9	UHS5XX	Industrial Management and Entrepreneurship	3	0	0	3
		Total Credit				20
MINOR						
1	UCS5M1	Neural Network & Deep Learning	3	1	0	4
2	UCS5ML1	Neural Network & Deep Learning lab	0	0	2	1
For other Department (ECE, IE)						
1	UCS509	Data Structures using C	3	0	0	3

Course Code	Course Title	L	T	P	C
UCS501	Computer Networks	3	0	0	3

Prerequisites: Programming for Problem Solving (UCSE201)

Module 1: Introduction [4L]
History of networking, OSI, TCP/IP and other networks models, Examples of Networks: Novell Networks, Arpanet, Internet, Network Topologies WAN, LAN, MAN.

Module 2: Physical Layer [6L]
Design issues, physical media introduction, transmission media, types of media, guided media, unguided media, copper, twisted pair, coaxial cables, UTP, STP, fiber-optic cables, working principle of fiber optic cables, wireless, microwave, satellite, switching and encoding asynchronous communications; Narrow band, broadband, ISDN and ATM.

Module 3: Data link layer [6L]
Design issues, framing, error detection and correction, CRC, Elementary Protocol stop and wait, Sliding Window, Slip, Data link layer in HDLC, Internet, ATM. Data Link sublayers, ALOHA, MAC, LLC, MAC addresses, CSMA, CSMA/CD. IEEE 802.X Standard Ethernet, wireless LANS. Bridges.

Module 4: Network Layer [8L]
Design issues, packet structure, IP addressing, different versions of IP address, classes of IP, concept of private/public IP, subnetting, CIDR, virtual circuit and datagram subnets-Routing, routing algorithm, routing protocols, distance vector routing protocol, link state routing protocol, routing information protocol and its versions, shortest path routing, flooding, hierarchical routing, broadcast, multicast, anycast, dynamic routing. Congestion, Congestion Control Algorithms – General Principles – of Congestion prevention policies. Internetworking: The Network layer in the internet and in the ATM Networks.

Module 5: Transport Layer [6L]
Design issues, Transport Services, Connection management, three-way handshaking protocols, TCP and UDP protocols; ATM AAL Layer Protocol, socket, port, client/server communication.

Module 6: Application Layer [5L]
HTTP, SMTP, POP, IMAP, DHCP, DNS, FTP, Telnet, Network Security, TLS, SSL, WWW.

TEXT BOOKS:
1. Computer Networks — Andrew S Tanenbaum,4th Edition. Pearson Education/PHI
2. Data Communications and Networking – Behrouz A. Forouzan.Third Edition TMH.

REFERENCES:
1. An Engineering Approach to Computer Networks-S.Keshav, 2nd Edition, Pearson Education
2. Understanding communications and Networks, 3rd Edition, W.A. Shay, Thomson

Course Code	Course Title	L	T	P	C
UCS571	Computer Networks - Lab	0	0	2	1

Unit 1: Introduction to Networks

Lab 1: Identify the different types of networks LAN, MAN, WAN in the campus and make a report

Lab 2: Identify and list out all the important devices of networking. Explore how the devices get connected to each other and able to communicate with each other and make a report.

Lab 3: Setup a packet tracer in your lab/home computer and make a layout of network using different components

Unit 2: Physical Layer

Lab 4: Setup a LAN that can communicate among the virtual devices inside the packet tracer

Lab 5: Extend the LAN that is set up in Lab 4 for so that it works in the real world. Setup a physical LAN network using UTP cables, RJ45, Crimpers, switch/hub and machines connected using this setup should communicate with each other.

Lab 6: Explore possibility of setting up fiber optic connection physically. Identify various components required for setting up a fiber optic connection.

Unit 3: Data link layer

Lab 7: Using packet tracer/wireshark identify the data link layer frame structure

Lab 8: Perform some lab work that demonstrates MAC, ARP etc.

Unit 4: Network Layer

Lab 9: Create a network and multiple subnetworks in the packet tracer and make them able to communicate with each other.

Lab 10: Lab that demonstrate routing in the packet tracer

Lab 11: Configure routing with various protocols like RIP, BGP, EGP etc

Unit 5: Transport Layer

Lab 12: Write a C/C++/Java program to demonstrate socket programming

Lab 13: Write a program to demonstrate client/server communication protocol

Unit 6: Application

Lab 14: Configure an SMTP/IMAP/POP to send/receive email, DHCP server to allocate IP addresses, HTTP server to serve html documents, ftp to access files, ssh to access remote server.

References:

Software: CISCO Packet tracer, Boson NetSim

OS: Linux/Windows having specialised software installed for the specific purpose.

Application Softwares: DHCP Server, FTP Server: filezilla server, openftp, opensmtpd, HTTP- Apache, nginx, SSH-OpenSSH, termius, sshd, putty

Course Code	Course Title	L	T	P	C
UCS502	Machine Learning	3	1	0	4

Module 1: Introduction to ML, role of ML in computer science and problem solving. Presentation of data (feature), matrix vector representation in the context of data. Problem formulations (classification and regression). Concept of supervised, unsupervised. Probability distributions in the context of data.

Module 2: PCA and Dimensionality Reduction, Nearest Neighbours and KNN. Linear Regression, Decision Tree Classifier, Notion of Generalization and concern of over fitting. Notion of Training, Validation and Testing; Connect to generalisation and over fitting.

Module 3: Ensembling and RF, Linear SVM, K Means, Logistic Regression, Naive Bayes

Module 4: Neural Network, Role of Loss Functions and Optimization, Gradient Descent and Perceptron/Delta Learning, MLP, Backpropagation, MLP for Classification and Regression, Regularisation, Early Stopping, Introduction to Deep Learning, CNNs.

Text Book

Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing Company, New Delhi
Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press (23 April 2020)
Tom M. Mitchell- Machine Learning- McGraw Hill Education, International Edition
Aurélien Géron Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, Inc. 2nd Edition

References:

Ian Goodfellow, Yoshoua Bengio, and Aaron Courville Deep Learning MIT Press Ltd, Illustrated edition Christopher M. Bishop Pattern Recognition and Machine Learning- Springer, 2nd edition
Trevor Hastie, Robert Tibshirani, and Jerome Friedman - The Elements of Statistical Learning: Data Mining, Inference, and Prediction- Springer, 2nd edition

Course Code	Course Title	L	T	P	C
UCS572	Machine Learning - Lab	0	0	2	1

- Familiar with the python packages related to the machine learning.
- Generate random data (number) for two class classification
- Generate random data (number) for two class classification
- Save the generated data in .csv or any other file
- Read the data from the .csv file and graphically display them
- Generate nearly / nearly linear random data set. Test their linearity (correlation coefficient)
- Linear Regression for a sample training data set stored as a .CSV file. Compute Mean Square Error.
- Implement Linear Regression with some real life data set.
- Implement the Non-linear Regression for a sample training data set stored as a .CSV file. Compute Mean Square Error.
- Implement the Logistic Regression for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier.
- Implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier.
- Implement k-Nearest Neighbor algorithm to classify the iris data set. Print both correct and wrong predictions.
- Implement Support Vector Machine algorithm to classify the iris data set. Print both correct and wrong predictions.
- Implement a single neural network and test for different logic gates.
- Implement a decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
- Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.

References:

Aurelien Geron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, Oreilly, March 2017.

Dr. M Gopal, Applied Machine Learning, 1st Edition, McGraw-Hill, 2018

Course Code	Course Title	L	T	P	C
UCS503	Introduction to Database Systems	3	0	0	3

Module 1: Foundations [3L]
Introduction: Database System Concepts and architecture, Data models, scheme and instances, Data independence Database language and Interface.

Module 2: Entity Relationship Model and Relational Data Model and Language [9L]
Data Modelling Using the Entity-Relationship Model: ER model concepts, Notations for ER diagram, Extended E.R. model, Relation ships of higher degree. Relational Data Model and Languages: Relational data Model concepts, constraints, relational algebra. Relational Calculus, Tuple and Domain calculus. SQL, data definitions queries and up-dates in SQL, QBE, Data definitions, queries and up-dates in QBE

Module 3: DBMS Software [5L]
Example DBMS System (MySQL/ORACLE/INGRESS/SYBASE), Basic architecture. Data definitions Data Manipulation.

Module 4: Database Design [7L]
Functional dependencies, Normal forms, First, second, and third functional personal normal forms. BCNF. Multivalued dependencies Fourth Normal form. Join Dependencies and fifth Normal form, Inclusion Dependencies.

Module 5: Query Processing and Optimisation [5L]
Algorithms for executing query operations, Heuristics for query optimisations.

Module 6: Transaction and Concurrency [6L]
Transaction and system concepts, schedules and Recoverability serializability of schedules.
Concurrency Control Techniques: Locking Techniques for concurrency control Time stamping and concurrency control.

Text & References Books:

1. Raghu Ramakrishnan and Johannes Gehkre, “Database Management System”, Mc. Graw Hill, Third Edition 2. Elmasri, Ramex Shamkant B. Navathe, "Fundamentals of Data base Systems".
3. Jeffry D. Ulman, "Principles of Data Base Systems", Second Edition Galgotia Pub.
4. Date, C.J. "An Introduction to Database System", Vol. I, II & IIIrd, Addison-Welsey.
5. Prakash, Naveen., "Introduction to Database Management", Tata McGraw Hill

Course Code	Course Title	L	T	P	C
UCS573	Introduction to Database Systems - Lab	0	0	2	1

#1: Draw an E-R diagram and convert entities and relationships to a relation table for a given scenario. Two assignments shall be carried out i.e. consider two different scenarios (eg. bank, college)

#2: Write relational algebra queries for a given set of relations.

Perform the following:

Viewing all databases, Creating a Database, Viewing all Tables in a Database, Creating Tables (With and Without Constraints), Inserting/Updating/Deleting Records in a Table, Saving (Commit) and Undoing (rollback)

Altering a Table, Dropping/Truncating/Renaming Tables, Backing up / Restoring a Database.

#3: For a given set of relation schemes, create tables and perform the following Simple Queries, Simple Queries with Aggregate functions, Queries with Aggregate functions (group by and having clause), Queries involving- Date Functions, String Functions , Math Functions Join Queries- Inner Join, Outer Join Subqueries- With IN clause, With EXISTS clause

#4: For a given set of relation tables perform the following

Creating Views (with and without check option), Dropping views, Selecting from a view

#5: Write a Pl/SQL program using FOR loop to insert ten rows into a database table.

#6: Given the table EMPLOYEE (EmpNo, Name, Salary, Designation, DeptID) write a cursor to select the five highest paid employees from the table.

#7: Illustrate how you can embed PL/SQL in a high-level host language such as C/Java And demonstrates how a banking debit transaction might be done.

#8: Given an integer i, write a PL/SQL procedure to insert the tuple (i, 'xxx') into a given relation

#9: Connecting/Executing Database from client side using programming language like

(PHP/Java/C/C++/Dart etc.)

#10: A Lab project/projects as determined by the instructor.

Tools and Tutorials

1. MySQL Software, https://www.mysql.com/
2. MySQL Workbench, ER -> DB Model, https://www.mysql.com/products/workbench/
3. SQL and PL/SQL tutorial: https://www.w3schools.com/sql/, http://www.plsqltutorial.com/

Course Code	Course Title	L	T	P	C
UCS504	Operating Systems	3	0	0	3

Module 1: Introduction [3L]
Introduction: Objectives and functions of OS, Evolution of Operating Systems,

Module 2: Process [4L]
Structural overview Process description and control: Process states, Process description, Process control, Process and threads, Examples of process description

Module 3: CPU Scheduling [6L]
Uniprocessor scheduling: Types of CPU scheduling, CPU Scheduling algorithms.

Module 4: Process Synchronization [6L]
Concurrency: Principles of concurrency, mutual exclusion, Software and Hardware approaches, Semaphores, Monitors, Message passing, readers/writers problem, Dining philosopher's problem.

Module 5: Deadlock [4L]
Principles of deadlock, Deadlock prevention, Detection and avoidance,

Module 6: Memory Management [7L]
Memory management requirements, Loading program into main memory, Virtual memory, Hardware and control structures, OS software, Examples of memory management.

Module 7: I/O and Disk[7L]
I/O management and disk scheduling

Module 8: File Management [5L]
File management and security: Overview of file management, File organization and access, File directories, File sharing, Record blocking, Secondary storage management, Case study: Unix file system, inodes, inode assignment to a new file, super block.

Text Books:
1. A. Silbershatz, P.B. Galvin and Gagne, "Operating System Concepts", Addison- Wesley, 2005.
2. Maurice J. Bach "The design of the UNIX operating system", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.

Reference Books:
1. A. S. Tanenbaum "Operating System Design and Implementation", 3rd Ed., Practice Hall of India, 2004.
2. W. Stalling, "Operating Systems: Internals and Design Principles", 5th Ed., Prentice Hall of India, 2007.
3. H. N. Dietel "An Introduction to Operating Systems", Addison Wesley, 1990.

Course Code	Course Title	L	T	P	C
UCS574	Operating Systems - Lab	0	0	2	1

List of Programs:
1. Simple Unix-C (at least two) programs using system calls to read and write strings on standard I/O devices and files.
2. Implementation of starting a new process, replacing a process image, duplicating a process image, waiting for a process, zombie process.
3. Implementation of the Dining Philosopher problem using shared memory and semaphore.
4. Implementation of a bounded-buffer problem using shared memory and semaphore.
5. Implementation of FCFS process scheduling techniques.
6. Implementation Shortest Job First (both preemptive and non-preemptive version) process scheduling techniques.
7. Implementation Round Robin process scheduling techniques.
8. Implementation for simulating page replacement algorithms like FIFO, Optimal and LRU.
9. Implementation of threads using POSIX or using thread class in Java.
10. Implementation of (at least one) deadlock avoidance techniques.

Text Books:
1. Stevens, “UNIX programming”, Pearson Education, Pearson Education, 2004.

Course Code	Course Title	L	T	P	C
UHS5XX	Industrial Management and Entrepreneurship	3	0	0	3

Contents need to be updated from HSS

MINORS

Course Code	Course Title	L	T	P	C
UCS5M1	**Neural Network & Deep Learning**	**3**	**1**	**0**	**4**

Prerequisites: Introduction to AI, Machine Learning & Data Analytics (UCS4M1)

Module 1: Introduction to Neural Network [3L]
Neural Network, Human Brain, Models of an Artificial Neuron and Neural Networks, Network Architectures, Knowledge Representation, Learning Process.

Module 2: Single Layer Perceptron [6L]
Single Layer Perceptron and Model, Convergence Theorem, Limitation of Single Layer Perceptron, XOR Problem, Activation Function.

Module 3: Multilayer Perceptron [8L]
Multilayer Perceptron, Gradient Descent and Back Propagation, Associative Memory, Bidirectional Associative Memory, Self-Organizing Maps, Radial Basis Function Network.

Module 4: Deep Learning [9L]
Fundamental of Deep Learning and Different from Machine Learning, Depp Learning Networks, Recurrent Neural Networks (RNN), Long Short Term Memory (LSTM), Bidirectional LSTMs, Gated Recurrent Units GRU), Convolutional Neural Networks (CNN).

Module 5: Deep Learning applications [4L]
Image Processing, Natural Language Processing, Speech Recognition, Video Analytics.

TEXT BOOKS:

1. Neural Networks, A Comprehensive Foundation, 2nd Edition, by Simon Haykin
2. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

REFERENCES:

1. Neural Networks and Deep Learning by Michael A. Nielsen, Determination Press 2015
2. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
3. Deep Learning (Adaptive Computation and Machine Learning series) Illustrated Edition by Ian Goodfellow, Yoshua Bengio, Aaron Courville.
4. Neural Networks and Deep Learning, 1st ed. 2018 Edition, Kindle Edition by Charu C. Aggarwal

Course Code	Course Title	L	T	P	C
UCS5ML1	**Neural Network & Deep Learning lab**	**0**	**0**	**2**	**1**

1. Lab 1: Implementing the Single Layer Perceptron (from Scratch)

- **Module:** 2 (Single Layer Perceptron)
- **Objective:** To understand the fundamental mechanics of a neuron, the learning rule, and convergence.
- **Task:** Implement the Perceptron learning algorithm from scratch in Python (using only numpy). Train it on a simple, linearly separable dataset (e.g., two classes from the Iris dataset). Students should plot the decision boundary as it learns.

2. Lab 2: Demonstrating the XOR Problem

- **Module:** 2 (Limitation of Single Layer Perceptron)
- **Objective:** To visualize and prove the limitation of a single-layer perceptron.
- **Task:** Create the XOR dataset (inputs: [0,0], [0,1], [1,0], [1,1]; outputs: [0, 1, 1, 0]). Apply the Perceptron algorithm from Lab 1 (or a library equivalent) to this dataset and show that it fails to converge and find a solution.

3. Lab 3: Solving XOR with a Multilayer Perceptron (MLP)

- **Module:** 3 (Multilayer Perceptron)
- **Objective:** To understand how adding a hidden layer (non-linearity) overcomes the limitations of the SLP.
- **Task:** Build a simple MLP using a library (e.g., Keras Sequential model) with one hidden layer (e.g., 2 input nodes, 2 hidden nodes, 1 output node). Train it on the XOR dataset from Lab 2 and demonstrate that it successfully solves the problem.

4. Lab 4: MLP for Image Classification (MNIST/Fashion-MNIST)

- **Module:** 3 (Multilayer Perceptron, Back Propagation)
- **Objective:** To build a practical image classifier using a "deep" stack of fully-connected layers and understand the backpropagation process (via the .fit() command).
- **Task:** Load the MNIST or Fashion-MNIST dataset. Build an MLP (e.g., Input -> Flatten -> Dense -> Dense -> Output) to classify the 10-digit/clothing categories. Experiment with a key hyperparameter, such as the number of hidden layers or the type of activation function.

5. Lab 5: Exploring Activation Functions

- **Module:** 2 (Activation Function)
- **Objective:** To visually understand the behavior and impact of different activation functions.
- **Task:** Plot the graphs for common activation functions (Sigmoid, Tanh, ReLU, Leaky ReLU). Then, use the MLP model from Lab 4 and train it multiple times, swapping out the activation

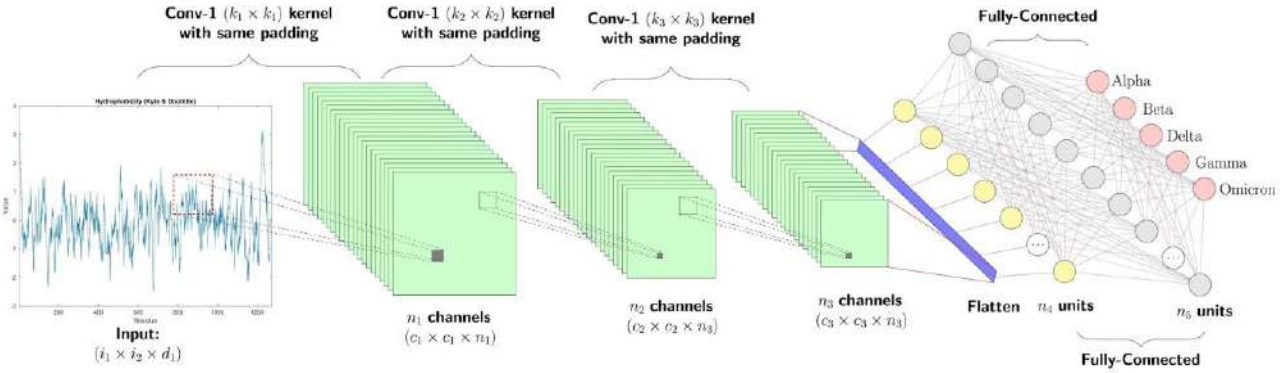
function (e.g., once with Sigmoid, once with ReLU). Compare the training speed (epochs to convergence) and final accuracy.

6. Lab 6: Self-Organizing Maps (SOM) for Clustering

- **Module:** 3 (Self-Organizing Maps)
- **Objective:** To implement an unsupervised neural network for clustering and dimensionality reduction.
- **Task:** Use a library (like MiniSom) to implement an SOM. Train it on the Iris dataset (using only the 4 features, without the class labels). Visualize the resulting map and see if the different species (which were unknown to the model) naturally cluster in different regions of the map.

7. Lab 7: Convolutional Neural Network (CNN) for Image Classification

- **Module:** 4 (Convolutional Neural Networks)
- **Objective:** To build a CNN, the standard architecture for image processing, and compare its performance to the MLP.
- **Task:** Use the CIFAR-10 dataset (which is harder than MNIST). Build a simple CNN (e.g., Conv2D -> MaxPooling2D -> Conv2D -> MaxPooling2D -> Flatten -> Dense -> Output). Train the model and compare its accuracy to the MLP from Lab 4 (on MNIST, or a new MLP on CIFAR-10).



8. Lab 8: Sentiment Analysis with a Simple Recurrent Neural Network (RNN)

- **Module:** 4 (Recurrent Neural Networks)
- **Objective:** To understand how to process sequential data (text) using an RNN.
- **Task:** Use the IMDB movie review dataset (a binary sentiment classification task). Build a model using an Embedding layer followed by a SimpleRNN layer and a Dense output layer. Train it to classify reviews as positive or negative.

9. Lab 9: Improving Sentiment Analysis with LSTMs and GRUs

- **Module:** 4 (LSTM, GRU)
- **Objective:** To solve the vanishing gradient problem of simple RNNs by using more advanced gated units.
- **Task:** Take the model from Lab 8. Create two new versions: one replacing the SimpleRNN layer with an LSTM layer, and another with a GRU layer. Train all three models (RNN, LSTM, GRU) for the same number of epochs and compare their final accuracy and learning curves.

10. Lab 10: Application - Transfer Learning for Image Processing

- **Module:** 5 (Deep Learning applications: Image Processing)
- **Objective:** To apply a key deep learning technique (transfer learning) by using a pre-trained model.
- **Task:** Use a pre-trained model (like **VGG16** or **ResNet50**, with weights from "ImageNet"). Load the model, "freeze" the convolutional base, and add your own new classifier on top (e.g., a Dense layer). Train this new classifier on a small, specific dataset (e.g., "cats vs. dogs"). This demonstrates how to get high accuracy with very little data and training time.

Course Code	Course Title	L	T	P	C
UCS509	Data Structures using C	3	0	0	3

Course Objectives: Strong understanding of fundamental data structures and algorithms. Enable students to implement these data structures and algorithms. Problem-solving abilities to choose appropriate data structures and algorithms. Understand complexity analysis and prepare for real-world applications

Module 1: Introduction: Basic Terminology, Elementary Data Organization, Algorithm, Efficiency of an Algorithm, Abstract Data Types (ADT), Structures, Union. Performance of algorithms: Space and Time complexity measures, asymptotic notations, Best case, Worst case and Average case analysis, Lower and Upper bounds, Operations on data.
Module 2: Arrays: Definition, Single and Multidimensional Arrays, Concept of Pointers, Representation of Arrays: Row Major Order and Column Major Order, Application of arrays, Sparse Matrices and their representations.
Module 3: Linked lists: Array Implementation and Dynamic Implementation of Singly Linked Lists, Doubly linked List, Circularly Linked List, Operations on a Linked List- Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List.
Module 4: Stacks: Introduction, Primitive Stack operations: Push & Pop, Array and Linked Implementation of Stack, Application of stack: Prefix and Postfix Expressions, Evaluation of postfix expression, Recursion, Tower of Hanoi Problem, Simulating Recursion, Principles of recursion, Tail recursion, Removal of recursion.
Module 5: Queues: Introduction, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, Array and linked implementation of queues, Dequeue and Priority Queue, Application of queues.
Module 6: Trees: Basic terminology, Binary Trees, Binary Tree Representation: Array and Linked Representation, Complete Binary Tree, Algebraic Expressions, Extended Binary Trees, Tree Traversal algorithms: Inorder, Preorder and Postorder. Graphs.
Module 7: Searching: Sequential search, Binary Search. Internal Sorting: Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Merge Sort, Heap Sort.

Course Outcome: Upon successful completion of the course, students will be able to demonstrate understanding and implementation of basic data structures. Apply algorithmic techniques utilize searching, sorting, and recursive algorithms to solve computational problems. Evaluate the time and space complexity of algorithms. Choose and apply appropriate data structures and algorithms to design efficient solutions for given problems.

Books/References:

1. Data Structures and Algorithms, A. V. Aho, J. E. Hopcroft, J. E. Ullman, Addison Wesley.
2. Fundamentals of Data Structures, E. Horowitz, S. Sahni, Galgotia Publ.
3. Data Structures using C, A.S. Tanenbaum
4. Algorithms, Data Structures, and Problem Solving, Addison Wesley.
5. Data Management and File Structures, Loomis, Marry, PHI
6. Data Structures & Algorithm Analysis in C++, M. A. Weiss, Addison Wesley.
7. Theory and Problems of Data Structures, Lipschutz, McGraw Hill.
8. Learning with C++, Neil Graham, McGraw Hill

COURSE STRUCTURE

AND

SYLLABUS FOR

B. TECH PROGRAMME

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

SEMESTER V

(APPLICABLE FROM AY 2024-2025 ADMITTED BATCH ONWARDS)

Course Structure							
5th Semester / 3rd Year							
Name of the Programme		**B.Tech**					
Name of the Department		**ECE**					
A.		**Theory Courses**					
Sl No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**Coordinating Department**
1	UEC501	Digital Communication	3	0	0	3	ECE
2	UEC502	Electromagnetic Waves	3	0	0	3	ECE
3	UEC503	Linear Integrated Circuits	3	0	0	3	ECE
4	UEC51*	Program Elective-1	3	0	0	3	ECE
5	UCS???	Data Structures	3	0	0	3	CSE
6	UHS501	Industrial Management and Entrepreneurship/ Industrial training	3	0	0	3	HSS
Total of A						**18**	
B.		**Laboratory/Project/Seminar Courses**					
Sl No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**Coordinating Department**
7	UEC571	Communication Engineering Lab	0	0	2	1	ECE
8	UEC573	Linear Integrated Circuits Lab	0	0	2	1	ECE
Total of B						**2**	
Grand Total (A+B)						**20**	

Name of the Programme:	B. Tech in **Electronics & Communication Engineering**
Semester:	**5**
Course Code:	**UEC501**
Course Title:	**Digital Communication**
Course Credit:	3 (L: 3 T: 0 P: 0)
Course objective:	1. **Understanding** Digital Signal Fundamentals 2. **Analyzing** System Components and Communication Channels 3. **Applying** Analytical Tools for Performance Evaluation (BER, Bandwidth efficiency)
Pre-requisites:	Signals and systems, Analog communication
Course outcomes: *	After completion of this course students will 1. Investigate pulsed modulation system and analyse their system performance 2. Analyse different digital modulation schemes and can compute the bit error performance 3. Make use of theorems related to random signals and processes4. To understand propagation of random signals in LTI systems.

Unit/ Module no.	**Topic**	**Nos. of contact hours**	**Distribution of marks (out of 100)**
1	Review of probability and random process. Introduction to digital communication, Pulse modulation: Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation.	6	
2	Noise considerations in PCM, Time Division multiplexing, Line coding: PSD of various line codes. Pulse shaping, Nyquist criterion for zero ISI. Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion.	8	
3	Pass band Digital Modulation schemes – Amplitude shift keying Phase shift keying, Frequency shift keying, Quadrature Amplitude Modulation (QAM). The optimum filter, matched filter, probability of error using matched filter, coherent reception, non-	7	

	coherent detection of FSK, calculation of error probability of ASK, BPSK, BFSK, QPSK.		
4	Specification of a random process, Autocorrelation function of a random process, Power Spectral Densities of Signals: Bandpass Signals and Spectra, Bandpass Stationary Random Process and PSD, Power Spectral Densities of Digital Signals: (A) Data symbols are uncorrelated (B) Data symbols are correlated, Power Spectral Densities of Digital Bandpass Signals.	8	
6	Transmission of random process through linear systems. Bandpass random process: Bandpass White Gaussian Random Process, Sinusoidal in Noise. Optimum filtering: Wiener-Hopf filter. IQ modulation: Impact of phase mis-alignment in receiver LO, Polar, Frequency domain representation, I/Q Transceiver frequency domain.	7	

Text Books:

1. S. Haykin, “Digital Communications”, John Wiley and Sons, 2001.
2. B.P. Lathi, Zhi Ding, “Modern Digital and Analog Communication Systems”, Oxford University Press, 2017.

Reference Books:

1. Fuqin Xiong, “Digital modulation techniques”, Artech House Inc., 2000.
2. J. M. Wozencraft and I. M., Jacobs I. M., “Principles of Communication Engineering", John Wiley, 1965.
3. L. W. Couch II, “Digital and Analog Communication Systems”, 3rd Ed., New York: Macmillan. 1990.
4. R. E. Ziemer, R. L. Peterson, “Introduction to Digital Communication”, Prentice-Hall Inc., 2001.
5. Tri T. Ha, “Theory and Design of Digital Communication Systems”, Cambridge University Press, 2010.
6. B. Sklar, “Digital communication: Fundamentals and Applications”, Prentice Hall, 2001.

Course Code:	**UEC571**
Course Title:	**Communication Engineering Lab**
Course Credit:	1 (L: 0 T: 0 P: 2)
Course objective:	1.Understand core communication principles 2. Develop practical skills on modulation and demodulation techniques such as AM, FM, ASK, FSK, and PSK 3. Bridge theory and application 4. Develop the ability to design, simulate, and troubleshoot basic analog and digital communication systems
Pre-requisites:	Basic knowledge of any simulation software, Analog and digital communication.
Course outcomes: *	After completion of this course students will 1. Demonstrate modulation techniques (like AM, FM, ASK, PSK etc.) 2.Investigate sampling principles 3. Analyze signal transmission 4. Design and evaluate analog and digital systems

Unit/ Module no.	Topic	Nos. of contact hours	Distribution of marks (out of 100)
1	Study of transistorized AM circuit and calculation of mod. index.	2	
2	Study of ring mod. circuit.	2	
3	Study of AM demodulator circuit.	2	
4	Study of DSB-SC and DSB-FC using AD633 multiplier IC circuit. Study of DSB-SC demodulation.	2	
5	Study of FM generation using sine-wave VCO.	2	
6	Study of FM demodulation using discriminator circuit.	2	
7	Study of PAM circuit and a demod. circuit.	2	
8	Study of a transistorized ASK, PSK modulator and demodulator.	2	
9	Study of a transistorized FSK modulator and demodulator.	2	
10	Study of BER for BPSK and BASK in AWGN channel.	2	
11	Make-up/practice lab	4	

Text Books:

1. B. Sklar, “Digital communication: Fundamentals and Applications”, Prentice Hall, 2001.
2. J. G. Proakis, M. Salehi and G. Bauch, “Modern communication systems using MATLAB”, 3rd Ed., Cengage Learning, 2013.

Course Code:	**UEC502**
Course Title:	**Electromagnetics and Wave Propagation**
Course Credit:	3 (L: 3 T: 0 P: 0)
Course objective:	1. **Understanding** the vector analysis and orthogonal systems 2. **Understanding Fundamental Laws**: To introduce the basic laws and concepts of electromagnetism, including Coulomb's law, Gauss's Law, Biot-Savart's law, and Ampere's circuital law. 3. **Mastering Maxwell's Equations**: To enable students to derive and apply Maxwell's equations in both static and time-varying field scenarios, as the fundamental basis for all electromagnetic phenomena. 4. **Analyzing Wave Propagation**: To impart knowledge on the concepts of electromagnetic wave propagation in various media (e.g., free space, dielectrics, conductors, and at media interfaces), including characteristics like reflection, transmission, and skin depth. 5. **Analyzing Transmission Lines**: To provide a solid understanding of transmission lines and its applications in guiding electromagnetic energy
Pre-requisites:	Electrostatics, Vector analysis, Network theory
Course outcomes: *	1. **Understand and apply** the principles of vector calculus to electromagnetic problems in various coordinate systems (Cartesian, cylindrical, and spherical). 2. Obtain and analyze electric and magnetic fields for various charge and current configurations under static conditions using fundamental laws like Coulomb's Law, Gauss's Law, Biot-Savart Law, and Ampere's Law. 3. **Understand** the concepts of electric potential, potential energy, conductivity, current density, and the properties of dielectric and magnetic materials. 4. **Derive, understand and solve** electrostatic boundary-value problems by applying Poisson's and Laplace equations, Maxwell's equations in both integral and differential forms for time-varying fields and different media. 5. **Analyze** the propagation, reflection, and transmission of uniform plane waves in unbounded and bounded media (e.g., free space, dielectrics, and conductors), including concepts like skin effect. 6. **Describe** energy density in electric and magnetic fields and apply the Poynting theorem to understand power flow in electromagnetic waves. wave propagation through transmission lines and utilize tools like the Smith chart for impedance matching

Unit/ Module no.	Topic	Nos. of contact hours	Distribution of marks (out of 100)
1	Introduction to Electromagnetics Basics of Vector Analysis – orthogonal Coordinate Systems, Transformations of coordinate systems.	6	
2	Del operator; Gradient, Divergence, Curl – their physical interpretations; Laplacian operator	2	
3	Coulomb's law, electric field intensity, charge distribution. Gauss' law, flux density and electric field intensity. Divergence theorem. Current Densities, Conductors, Poisson's & Laplace's equations, Uniqueness theorem, Biot-Savart law, Ampere's law, Relation between J & H, Vector magnetic potential, Stokes' theorem.	6	
4	Faraday's law & Lenz's law, Displacement Current, J_C – J_D relation, Maxwell's equations, Time-harmonic fields, Wave Equation, Boundary Conditions between media interface;	5	
5	Uniform Planewave; Wave Propagation in Lossy Dielectric, Loss-less Dielectric, Free space, Polarization of waves. Poynting Theorem, Power flow, Poynting vector, Skin Depth, Surface Resistance, Reflection and Transmission of waves for normal incidence and oblique incidence.	7	
6	Transmission Lines: Concept of Lumped and Distributed parameters, Line Parameters, Transmission line equations and solutions, Physical significance of the solutions. Propagation constant, Characteristic Impedance; Wavelength; Velocity of Propagation; Distortion-less Line Reflection and Transmission coefficients; Standing Waves, VSWR, Input Impedance, Smith Chart Applications.	10	

Text Books:

1. Electromagnetic Waves & Radiating Systems, 2ed Edition –E. C. Jordan and K.G. Balmain, Pearson Education
2. Elements of Electromagnetics, 4th Edition – Matthew N O Sadiku, Oxford University Press
3. Engineering Electromagnetics, 2ed Edition - Nathan Ida, Springer India
4.Field and Wave Electromagnetics- D.K Cheng, Addison-Wesley Educational Publishers Inc (1 December 1983)

Reference Books:

1. Electromagnetics, 2ed Edition – J A Edminister, Tata-McGraw-Hill
2. Electromagnetic Waves – R K Shevgaonkar, Tata-McGraw-Hill
3. Engineering Electromagnetics, 7thEdition-W. H. Hayt & J. A. Buck, Tata-Mc Graw-Hill

Course Code:	UEC503
Course Title:	Linear Integrated Circuits

Course Credit:	3 (L: 3 T: 0 P: 0)
Course objective:	1. Develop a detailed knowledge of general-purpose operational amplifiers (Op-Amps) 2. Employ the Op-Amps in the design of amplifiers, voltage regulators, filters, oscillators, and other signal conditioning circuits. 3. Explore applications of Op-Amps in the Data acquisition, signal conditioning and data conversion.
Pre-requisites:	Network theory, Analog electronics
Course outcomes: *	After completion of this course students will 1. Gain a basic understanding of electronic system design flow. 2. Be able to design Op-Amp based circuits for signal treatment in both Voltage, current domain. 3. Understand versatility of Op-Amp in data acquisition & conversion systems. 4. Understand the usage of feedback for signal generation

Unit/ Module no.	**Topic**	**Nos. of contact hours**	**Distribution of marks (out of 100)**
1	**Introduction to Electronic system Design:** Design flow of electronic systems, methodologies, Specifications, Electronic Products Classification: Consumer, Industrial and Military, Linear/Nonlinear, Analog signal conditioning, Choice of Op-Amps in signal conditioning applications. Op-amp, Specifications, types of op-amps, Comparison different topologies, µA741 IC Internal schematics & discussions.	10	
2	**Applications of Op-Amps:** Linear Applications: VCVS, VCCS, CCVS, CCCS implementation using Op-Amp, Differentiator, Integrator, Non-Linear Applications: Clippers and Clampers, Precision rectifier, Log and Antilog amplifiers, Comparators, PWM signal generation using comparator, Series/Shunt Regulator using OP-AMP. Discussions on: LM 317, 78XX, 79XX.	10	
3	**Data Acquisition& Conversion Systems:** Data Acquisition system and basics, Data Converters, Specifications, Types of D/A converters Current driven DAC, Types of A/D converters Flash, Single slope, Dual slope, Successive Approximation Register- Delta Sigma Modulation.	8	

4	**Signal Generation using Op-Amps:** Types of Signal generators, Specifications of Oscillators, Relaxation Oscillators, sine wave oscillators. Circuits and explanations, PLL: case study	8	

Text Books:

1. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4th edition, Mc-Graw Hill
2. William D. Stanley, Operational Amplifiers with Linear Integrated Circuits, Pearson, 2004.

Reference Books:

1. Lienig Jens, Bruemmer Hans. Fundamentals of Electronic Systems Design, Springer, 2007
2. Bruce Carter and Ron Mancini, Op Amps for Everyone, 5th Edition, Newnes, 2017
3. Behzad Razavi, Principles of Data Conversion System Design, Wiley-IEEE Press, 1995
4. Carusone, Johns, and Martin, Analog Integrated Circuit Design, 2nd edition, John Wiley, 2012.

Course Code:	**UEC573**
Course Title:	**Linear Integrated Circuits Lab**
Course Credit:	1 (L: 0 T: 0 P: 2)

Course objective:	1. Develop a detailed knowledge of Op-amp based applications 2. Test and validate the theory of Op-amp based circuits 3. Make a complete signal processing chain with several ICs for sensor domain.
Pre-requisites:	Analog electronics and Network Theory
Course outcomes: *	After completion of this course students will 1. Design the amplifier circuits for several arithmetic computations 2. Make the workable circuits and as per the specifications. 3. Understand versatility of Op-Amp in data acquisition & conversion systems. 4. Employ the negative and positive feedback around Op-amp for signal processing and wave generation respectively.

Unit/ Module no.	**Topic**	**Nos. of contact hours**	**Distribution of marks (out of 100)**
1	Implement VCCS through Op-Amp.	2	
2	Implement CCVS through Op-Amp.	2	
3	Implement Series voltage regulator with Op-amp.	2	
4	Design and explore Sample and Hold amplifier with Op-amp.	2	
5	Precision Half Wave Rectifier (Non saturating) Circuit using Op-Amp	2	
6	Square wave generator/triangular wave generator with Op-amp.	2	
7	Pulse width modulated wave generation with comparators and control the DC-DC converter.	2	
8	Study of R-2R DAC with Op-Amp.	2	
9	Implement Sigma-Delta ADC. (SPICE based/ Hardware Board).	2	
10	Implement an Analog to Digital converter. (Simulation/Hardware)	2	
11	Study and Analyse Howland Current Pump Circuit.	2	
12	Make-up/practice lab.	2	

Text Books:

1. William D. Stanley, Operational Amplifiers with Linear Integrated Circuits, Pearson, 2004.
2. James M. Fiore, OP Amps and Linear Integrated Circuits: Concepts and Applications, Cengage India.

Reference Books:

1. Operational Amplifiers and Linear Integrated Circuits, Robert F. Coughlin, Frederick F. Driscoll, Pearson Education.
2. Bruce Carter and Ron Mancini, Op Amps for Everyone, 5th Edition, Newnes, 2017

Program Elective – 1

Course Code:	**UEC511**
Course Title:	**Computer Architecture**
Course Credit:	3 (L: 3 T: 0 P: 0)

Course objective:	1. To understand the concept of advanced pipelining techniques 2. To understand the current state of art in memory system design 3. To know the working principle of I/O devices
Pre-requisites:	Foundations of computing systems
Course outcomes: *	1. State the history and development of modern computer systems. 2. Interpret data representation and computer arithmetic 3. Determine the key aspects of micro-architecture and instruction set architecture 4. Estimate performance of computer systems and suggest methods for performance enhancement 5. Specify the importance of memory hierarchy for efficient memory design and virtual memory 6. Describe emerging computing trends and some parallel architectures

Unit/ Module no.	Topic	Nos. of contact hours	Distribution of marks (out of 100)
1	**Introduction:** Classes of computers, Defining Computer Architecture – Trends in Technology – Trends in Power and Energy in Integrated Circuits – Trends in Cost – Dependability – Measuring, Reporting and Summarizing Performance – Quantitative Principles of Computer Design.	4	
2	**Instruction Set Architecture:** Representation of Instructions, Machine instructions, Operands, addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures.	6	
3	**Organization of a processor:** Registers, ALU and Control unit, Data path in a CPU, Instruction cycle, Organization of a control unit - Operations of a control unit, Hardwired control unit, Microprogrammed control unit, pipelining and pipeline hazards	8	
4	**Memory Subsystem:** Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal Organization of a memory chip, Organization of a memory unit, Interleaved memories, Cache memory unit - Concept of cache memory, Mapping methods, Organization of a cache-memory unit, Fetch and write mechanisms, Memory management unit - Concept of virtual memory, Address translation, Hardware support for memory management.	8	
5	**I/O Subsystem and System Interconnection:** I/O transfers - Program controlled, Interrupt driven and DMA, Privileged and non-privileged instructions, Software interrupts and exceptions.	7	

	Programs and process's role of interrupts in process state transitions		
6	**Advanced Topics:** Parallel architectures, SIMD, MIMD etc., Future trends	3	

Text Books:

1. Patterson, j.L.Hennessy, Computer Organization and Design: The Hardware/Software Interface, Morgan Kaufmann, 5th edition, 2013, ISBN-13:9780124078864
2. Smruti R Sarangi, Computer Organisation and Architecture, McGraw Hill Education, 1st edition, 2017, ISBN-13: 978-9332901834

Reference Books:

1. Andrew S. Tanenbaum, Structured Computer Organization, Prentice Hall, 6th edition, 2012, ISBN: 978-0132916523.
2. C. Hamacher, Z. Vranesic and S. Zaky, Computer Organization, McGraw-Hill, 5th edition,2002, ISBN: 0072320869.
3. J.L. Hennessy, D.A.Patterson, Computer Architecture: a quantitative approach, Morgan Kaufmann, 5th edition, 2011, ISBN: 978-1558605961.

Course Code:	**UEC512**
Course Title:	**Embedded Systems**
Course Credit:	3 (L: 3 T: 0 P: 0)
Course objective:	1. To get acquainted with modern embedded electronic systems. 2. To understand the design flow of an embedded product. 3. Understanding the RTOS concepts

	4. Learn and write the embedded C for small RTOS kernel.
Pre-requisites:	Microcontroller, C-Programming
Course outcomes: *	1. Understand the specifications for a targeted Embedded design 2. Formulate the hardware and firmware aspects of the design for the first pass. 3. On completion of the course, student will be able to design embedded System for real life problem. 4. Being adapted to recent technologies and devices for a specific design challenge. 5. Formulate the basic test mechanisms for an embedded application.

Unit/ Module no.	Topic	Nos. of contact hours	Distribution of marks (out of 100)
1	**Introduction to Embedded System** 1.1) Core of the embedded system, Memory, Sensors and Actuators Communication Interface, Embedded firmware; Examples: Smart card, ECU, ADAS, Smart Watch 1.2) Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency 1.3) Embedded Product development life cycle, Program modelling concepts: DFG, CDFG, FSM, Petri-net, UML	10	
2	**Embedded Hardware and Design** 2.1) Embedded RISC Processors: The ARM Design Philosophy, ARM processor Families, Core extensions, Architecture Revisions Arm Cortex-M4 Processor, 2.2) Hardware accelerators- CPUs and accelerators, accelerator system design. 2.3) Memory Systems: RAM, ROM, types of RAM and ROM, memory testing, CRC, Flash memory 2.4) Sensors/Actuators/RF Modules	8	
3	**Buses and I/O, Networking:** 3.1) Onboard communication interfaces-I2C, SPI, CAN, parallel interface; 3.2) External communication interfaces-RS232 and RS485, USB, infrared, Bluetooth, Wi-Fi, ZigBee, GPRS, GSM 3.3) Study of basic communication protocols like SPI, SCI (RS232, RS485), I_2C, CAN, LIN Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee; BLE	8	
4	**Embedded Software & Firmware Concepts**	10	

	4.1) Basic embedded C programs/applications, C Programs involving 8-bit AVR microcontrollers; Serial data transmission/ reception; programming with interrupts; SPI/I2C programming for EEPROM, ADC, DAC, RF Module; Programming involving ARM microcontrollers. 4.2) Real time operating system: Need of RTOS in Embedded system software, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling: non-pre-emptive and pre-emptive scheduling; task communication-shared memory, message passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques. 4.3) Test and Debug: Faults & Defects; strategies for test and debug, JTAG, Scan etc.		

Text Books:

1. Embedded Systems: Frank Vahid, Wiley India, 2002
2. Frank Vahid & Tony Givargis, "Embedded System Design-A Unified Hardware/Software Introduction", Third Edition, John Wiley & Sons Inc., Reprint 2010
3. G.H. Raghunathan, "Microcontrollers (ARM) & Embedded Systems" Cengage Learning.

Reference Books:

1. Introduction to Embedded Systems: Shibu K. V. (TMH)
2. Embedded Microcomputer Systems – Real Time Interfacing – Jonathan W. Valvano; Cengage Learning; Third or later edition
3. Steve Furber, "ARM System-on-Chip Architecture", 2nd Edition, Pearson Education, India ISBN: 9788131708408, 8131708403, 2015
4. Embedded Systems: Real-Time Interfacing to ARM Cortex M Microcontrollers, Fifth edition 2016, ISBN: 978-1463590154
5. Z. Yifeng, "Embedded Systems with ARM Cortex-M microcontrollers in Assembly Language and C", E-Man Press.

Course Code:	**UEC513**
Course Title:	**Optical Electronics**
Course Credit:	3 (L: 3 T: 0 P: 0)
Course objective:	1. To acquire knowledge about the optical processes in semiconductor 2. To understand the basics of optical sources. 3. To study about the optical detection processes. 4. To acquire the knowledge about the optical fiber.

	5. To gain knowledge about the optical power launching and power coupling in the optical fiber.
Pre-requisites:	Analog electronics
Course outcomes: *	After completion of this course students will 1. Understand the optical processes in semiconductor 2. Acquire knowledge about the different types of optical sources. 3. Understand the optical detection processes. 4. Understand the different types of optical fibers and their uses. 5. Able to know about the optical power launching and power coupling in the optical fiber.

Unit/ Module no.	**Topic**	**Nos. of contact hours**	**Distribution of marks (out of 100)**
1	**Semiconductor fundamentals:** Energy density function, Density of state function **Optical Processes in semiconductor:** Electron hole pair formation and recombination (direct and indirect band gap semiconductor). Radiative and non-radiative recombination, Auger recombination.	3	
2	**Optical Sources:** LED: Electroluminescent process, choice of material, device configuration and efficiency (injection, recombination, extraction and external conversion efficiency), Power and efficiency calculation. LED structure: Double hetero-structure diode, Burrus Surface emitting LED, Guided wave or Edge emitting LED, Super luminescent LED.	6	
3	**LASER:** Absorption and emission of radiation, Einstein relation, population inversion, threshold condition for laser oscillation, Types of Lase (gas, solid state, dye, semiconductor). Population inversion at a junction, Emission spectra for a p-n junction laser, Axial and transverse laser modes, Heterojunction Laser, Generation of pulses.	8	
4	**Photo Detectors:** Junction Photodiode (PIN, Heterojunction). Avalanche photodiode: Avalanche multiplication process, Avalanche multiplication and ionization coefficients. Photo transistor, Schottky barrier diode.	5	

5	**Optical fiber communication:** Introduction to Optical fiber communication, Basic Optical communication system, Ray theory of Transmission, Optical waveguide, Different types of optical fibers, step index fiber, Graded index fiber, Signal degradation on optical fiber due to dispersion and attenuation, Grin rod lenses, fiber couplers	8	
6	**Power launching and coupling** Sources and their output patterns, Power coupling calculation, equilibrium numerical aperture, coupling arrangements- lensing schemes for coupling improvement.	6	

Text Books:

1. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India 2/e
2. J.M Senior, Optical Fiber Communications: Principles and Practice, PHI, 3rd Ed.

Reference Books:

1. Keiser, Optical Fibre communication, McGraw-Hill, 4th Ed. 2010 (Indian Edition).
2. Amar K. Ganguly, Optical and Optoelectronic Instrumentation, Narosa Pulishing House,2010
3. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).
5. G. P. Agrawal, Fiber - Optic Communication Systems, Wiley, 5th Ed., 2021.

Course Code:	**UEC514**
Course Title:	**Analog Filter Design**
Course Credit:	3 (L: 3 T: 0 P: 0)
Course objective:	1. Understand filter fundamentals including frequency response, filter types (low-pass, high-pass, band-pass, band-stop), and their applications in signal processing.

	2. Apply design techniques and analyze analog filters using classical methods such as Butterworth, Chebyshev, and Elliptic approximations. 3. Integrate analog filters into real-world systems such as audio processing, biomedical devices, and RF circuits.
Pre-requisites:	Analog electronics, Network theory
Course outcomes: *	After completion of this course students will 1. Explain the theoretical foundations of analog filter 2. Analyze and design passive and active filter circuits 3. Implement standard approximation methods using Butterworth, Chebyshev, and Elliptic approximations to meet specific design criteria. 4. Evaluate filter performance such as gain, bandwidth, roll-off rate, and stability in real-world systems.

Unit/ Module no.	Topic	Nos. of contact hours	Distribution of marks (out of 100)
1	Review of Op-Amp and Op-Amp based circuits.	2	
2	**First order filters:** Bilinear transfer function and frequency response, Realization with passive zeros, Active realization: Inverting Op-Amp, Non-inverting Op-Amp, Differential Op-Amp circuits, Cascade design.	6	
3	**Second order low-pass and band-pass filters:** Design parameters Q and ω_0, second order circuit, Frequency response, Integrators, Inverting and Non-Inverting, Effect of A(s) on the Bi-quad, Sallen-Key circuits, General impedance converter (GIC) circuits.	6	
4	**Low-pass filters with maximally flat magnitude:** Ideal low-pass filter, Butterworth response, Butterworth pole locations, low-pass filter specifications.	5	
5	**Low-pass with equal-ripple Chebyshev magnitude response:** The Chebyshev polynomial, Magnitude response, Pole locations, Chebyshev filter design. Cauer magnitude response, Inverse Chebyshev response, Cauer filter design. Sensitivity: Bode sensitivity.	8	
6	**Frequency transformation:** Low-pass to high-pass, low-pass to band-pass, low-pass to band-reject transformation.	4	

7	**Switched capacitor filters:** The MOS switch, the switched capacitor, first order building blocks, second order sections, Design of switched-capacitor filters.	5	

Text Books:

1. L. P. Huelsman P. E. Allen, "Introduction to the theory and design of active filters", McGraw-Hill, 1980.
2. A. Waters, "Active filter design", Macmillan Education Ltd., 1991.

Reference Books:

1. S. K. Mitra, "Analysis and synthesis of linear active networks", Wiley, 1969.
2. C. Chen, "Active filter design", Hayden, 1982.
3. R. Schaumann, M. E. Van Valkenburg, "Design of analog filters" OUP, 2001.

Course Code:	**UCS*** **
Course Title:	**Data Structures**
Course Credit:	3 (L: 3 T: 0 P: 0)
Course objective:	1.

Pre-requisites:	
Course outcomes: *	After completion of this course students will 1

Unit/ Module no.	**Topic**	**Nos. of contact hours**	**Distribution of marks (out of 100)**
1			
2			
3			
4			
5			
6			

Text Books:

Reference Books:

Course Code:	**UHS501**
Course Title:	**Industrial Management and Entrepreneurship/ Industrial training**
Course Credit:	3 (L: 3 T: 0 P: 0)
Course objective:	The primary objective of this course is to provide engineering students with a broad understanding of management and entrepreneurial principles, equipping them to excel in managerial roles or to start and

	manage their own ventures. The Course Objectives for Industrial Management and Entrepreneurship are: 1. To gain knowledge of core management concepts, principles, and practices. 2. To develop skills in managing operations, including production planning, scheduling, and quality control. 3. To formulate and implement strategies for achieving organizational goals. 4. To understand the role of motivation, communication, and conflict resolution in managing teams. 5. To study different types of entrepreneurships, including social and corporate entrepreneurship. 6. To learn techniques for identifying and developing innovative business ideas. 7. To explore methods for market research and validation of business concepts.
Pre-requisites:	
Course outcomes: *	After completion of this course students will 1.Apply Management Theories: Demonstrate the ability to apply core management theories and principles to industrial scenarios, effectively addressing organizational and operational challenges. 2.Manage Resources Effectively: Develop strategies for the optimal management and allocation of resources, including human, material, and financial resources, to achieve organizational goals 3.Develop Viable Business Ideas: Generate and evaluate innovative business ideas, using market research and feasibility analysis to validate potential opportunities. 4.Implement Effective Marketing Strategies: Design and execute marketing and sales strategies to build brand awareness, attract customers and achieve market positioning. 5. Manage Start-up Operations: Demonstrate the ability to manage the day-to-day operations of a start-up, including handling team dynamics, scaling operations and managing growth effectively

Unit/ Module no.	Topic	Nos. of contact hours	Distribution of marks (out of 100)

1	Meaning and Concept of Management, Principles and function of Management, Concept and scope of Organizational Behavior, Function of a Manager—Planning, Organizing, Coordinating and Controlling, Motivation—implication of Managers and application. Leadership, Qualities and Styles of Leadership, Decision making process.	8	20
2	Individual Process in Organizations- Personality, Perception, and Attitude, Factors that affect them, how they influence people. Organizational Conflicts and Conflict Management, SWOT Analysis: Meaning and Significance, Job Satisfaction and Job Dis-Satisfaction: Meaning and Effect, Concept of Stress Management and Time Management	10	25
3	Evolution, Role and Status of Human Resource Management in India. Recruitment and Selection Process in Organization- Job Analysis-Job Specification-Selection Process-Test and Interview. Trade Union and Collective Bargaining.	8	15
4	Entrepreneurship-Meaning, Types of entrepreneurs, Qualities of an entrepreneur, Role of Entrepreneur, Factors affecting entrepreneurial growth. Entrepreneurship Development Programme-Concept, Objective and Importance, Modern Marketing Tools for Entrepreneurs, Business Idea: Meaning and Factors affecting generation of Business Idea, Concept of Creativity and Innovation for Startups. Business Opportunity Analysis.	8	25
5	Small Scale Industry-Definition, Types of Small-Scale Industry, How to Set up Small Scale Industry, Role and Problem of Small-Scale Industry, Concept of Joint Stock Company, Private and Public Limited Company, Meaning of IPR, Legal and Ethical Issues of the Entrepreneur	8	15

Text Books:

1. Khanka, S. S (2023), New-Delhi, Organizational Behavior, S.Chand & Company
2.Sarkar, S.S., Sharma, R. K. Gupta, S.K. (2021), New-Delhi, Business Organisation and Entrepreneurship Development, Kalyani Publishers
3.Debnath, Arabinda (2015), Guwahati, Principles of Management, BLG Publication
4.. Prasad, L.M. (2020), New-Delhi, Principles and Practice of Management, S. Chand& Company
5. Khanka, S.S. (2020), New Delhi, Entrepreneurial Development, S. Chand& Company
6. Debnath, Arabinda (2018), New Delhi, Industrial Management and Entrepreneurship, Kalyani Publishers

Reference Books:

1. Shukla, M.B. (2015), Guwahati, Entrepreneurship and Small Business Management, Kitab Mahal
2. Bhatia, Kanchan and Mittal, Shweta (2016), New-Delhi, Management Concept and Practice, Variety Books Publishers & Distributors

V SEM

A.		Theory Courses					
Sl No.	Course Code	Course Title	L	T	P	C	Coordinating Department
1	UHS501	Industrial Management and Entrepreneurship	3	0	0	3	HSS
2	UME501	Heat and Mass Transfer	2	1	0	3	ME
3	UFE501	Food Product Technology-III (Milk and Milk Products)	2	0	0	2	FET
4	UFE502	Food Process Engineering	2	1	0	3	FET
5	UFE503	Food Process Equipment Design	3	0	0	3	FET
6	UFE51*	Elective-II	2	0	0	2	FET
	UFE511	Food Industry Waste Management					
	UFE512	Genetically Modified Foods					
	UFE513	Separation Technology					
Total of A			**14**	**2**	**0**	**16**	
B.		**Laboratory/Project/Seminar Courses**					
Sl No.	Course Code	Course Title	L	T	P	C	Coordinating Department
1	UME571	Fluid and Thermal Engineering Lab	0	0	2	1	ME
2	UFE571	Product Technology-III Lab	0	0	2	1	FET
3	UFE572	Food Engineering Lab	0	0	2	1	FET
4	UFE573	Process Equipment Drawing	0	0	2	1	FET
Total of B			**0**	**0**	**8**	**4**	
C.		**Audit/Non-credit Courses**					
Sl No.	Course Code	Course Title	L	T	P	C	Coordinating Department
Total of C							
Grand Total (A+B+C)			**14**	**2**	**8**	**20**	

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UHS501
Course Title:	Industrial Management and Entrepreneurship
Course Credit:	3 (L: 3 T:0 P: 0)
Course objective:	• To gain knowledge of core management concepts, principles, and practices. • To develop skills in managing operations, including production planning, scheduling, and quality control. • To formulate and implement strategies for achieving organizational goals. • To understand the role of motivation, communication, and conflict resolution in managing teams. • To study different types of entrepreneurship, including social and corporate entrepreneurship. • To learn techniques for identifying and developing innovative business ideas. • To explore methods for market research and validation of business concepts.
Pre-requisites:	-
• **Course outcomes:***	After completion of this course, students will be able to • Demonstrate the ability to apply core management theories and principles to industrial scenarios, effectively addressing organizational and operational challenges. • Develop strategies for the optimal management and allocation of resources, including human, material, and financial resources, to achieve organizational goals. • Generate and evaluate innovative business ideas, using market research and feasibility analysis to validate potential opportunities. • Design and execute marketing and sales strategies to build brand awareness, attract customers and achieve market positioning.

	• Demonstrate the ability to manage the day-to-day operations of a start-up, including handling team dynamics, scaling operations and managing growth effectively.

Unit/ Module no.	Topic	No. of contact hours
1	Meaning and Concept of Management, Principles and function of Management, Concept and scope of Organizational Behavior, Function of a Manager—Planning, Organizing, Coordinating and Controlling, Motivation—implication of Managers and application. Leadership, Qualities and Styles of Leadership, Decision making process.	8
2	Individual Process in Organizations- Personality, Perception, and Attitude, Factors that affect them, How they influence people. Organizational Conflicts and Conflict Management, SWOT Analysis: Meaning and Significance, Job Satisfaction and Job Dis-Satisfaction: Meaning and Effect, Concept of Stress Management and Time Management	10
3	Evolution, Role and Status of Human Resource Management in India. Recruitment and Selection Process in Organization- Job Analysis-Job Specification-Selection Process-Test and Interview. Trade Union and Collective Burgaining.	8
4	Entrepreneurship-Meaning, Types of entrepreneur, Qualities of an entrepreneur, Role of Entrepreneur, Factors affecting entrepreneurial growth. Entrepreneurship Development Programme-Concept, Objective and Importance, Modern Marketing Tools for Entrepreneurs, Business Idea: Meaning and Factors affecting generation of Business Idea, Concept of Creativity and Innovation for Startups. Business Opportunity Analysis.	8
5	Small Scale Industry-Definition, Types of Small-Scale Industry, How to Set up Small Scale Industry, Role and Problem of Small-Scale Industry, Concept of Joint Stock Company, Private and Public Limited Company, Meaning of IPR, Legal and Ethical Issues of the Entrepreneur	8

Text Books:

1. *Khanka, S.S (2023) , New-Delhi, OrganisationalBehaviour , S.Chand& Company*
2. *Sarkar, S.S. , Sharma, R.K.andGupta, S.K. (2021), New-Delhi, Business Organisation and Entrepreneurship Development ,Kalyani Publishers*
3. *Debnath, Arabinda (2015), Guwahati, Principles of Management ,BLG Publication*
4. *Prasad, L.M. (2020), New-Delhi, Principles and Practice of Management , S.Chand& Company*
5. *Khanka, S.S.(2020), New Delhi, Entrepreneurial Development , S.Chand& Company*
6. *Debnath, Arabinda (2018), New Delhi, Industrial Management and Entrepreneurship, Kalyani Publishers*

Reference Books:

1. *Shukla, M.B. (2015), Guwahati, Entrepreneurship and Small Business Management, KitabMahal*
2. *Bhatia, Kanchan and Mittal, Shweta(2016),New-Delhi, Management Concept and Practice ,Variety Books Publishers & Distributors*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UME501
Course Title:	Heat and Mass Transfer
Course Credit:	3 (L: 2 T:1 P: 0)
Course objective:	The objectives of this course are • To build a strong foundation in the three fundamental modes of heat transfer: conduction, convection, and radiation. • To understand the governing equations of heat transfer and their solution procedures, and apply standard correlations to solve practical problems. • To evaluate heat transfer rates in forced and free convection using appropriate empirical correlations. • To learn the design of various types of heat exchangers using sizing and thermal analysis methods.
Pre-requisites:	• Engineering Thermodynamics and Fluid Mechanics.
Course outcomes:*	By the end of this course, students will be able to • Classify different types of heat transfer problems and solve their practical application. • Solve steady and unsteady conduction problems in plane walls, cylinders, spheres, and fins. • Derive and apply governing equations for solving external and internal forced convection, and free convection heat transfer problems. • Apply fundamental radiation laws to determine radiative heat exchange between surfaces. • Select suitable types of heat exchangers and understand the LMTD and Effectiveness-NTU methods. • Understand the fundamental principles of mass transfer and develop the ability to solve practical engineering problems involving simultaneous heat and mass transfer.

Unit/ Module no.	Topic	No. of contact hours
1	Introduction: Modes of heat transfer–conduction, convection and radiation; General heat conduction equation, Boundary conditions and their types.	4
2	Conduction Heat Transfer: 1-D and 2-D steady heat conduction through the plane walls, cylinders and spheres; Concept of thermal resistance and electrical analogy, Critical radius of insulation, Fins; 1-D unsteady conduction–Lumped system analysis; Solution of some specific conduction heat transfer problems.	8
3	Convection Heat Transfer: Fundamentals of convection heat transfer, Derivation of differential convection equations, Analogies between momentum and heat transfer; Velocity and thermal boundary layers; External and internal forced convection; Free convection; Solution of some specific convective heat transfer problems.	8
4	Radiation Heat Transfer: Fundamentals of thermal radiation, Stefan-Boltzmann law, Planck's law, emissivity, absorptivity, reflectivity and transmissivity; Radiant exchange between black surfaces.	6
5	Heat Exchangers: Classification of heat exchangers, Overall heat transfer coefficient, fouling factor, Analysis of heat exchanger: Log mean temperature difference (LMTD) and effectiveness–NTU methods.	5
6	Mass Transfer: Mass diffusion, Fick's law of diffusion, boundary conditions, Steady state mass diffusion; Mass convection.	5

Text Books & References:

1. *Bergman T. L., Lavine, A.S., Incropera P.F., and DeWitt, D.P., Fundamentals of Heat and Mass Transfer. John Wiley, 8th edition, 2018.*
2. *Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984.*
3. *Holman, J. P., Heat Transfer, McGraw-Hill, 8th Edition, 2001.*

4. *Nag, P.K., Heat and Mass Transfer, McGraw-Hill, 3rd Edition, 2011.*
5. *Bejan, A., Heat Transfer, John Wiley, 1st Edition, 2022.*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE501
Course Title:	Food Product Technology-III (Milk and Milk Products)
Course Credit:	2 (L: 2 T: 0 P: 0)
Course objective:	• To gain a clear and extensive knowledge on the principles of milk and milk products processing technologies • To have a comprehensive grasp on quality, nutrition, health, and consumers' acceptability of milk and milk products • To develop acumen for self-learning on prospective technological advancements in the area of milk and milk product processing
Pre-requisites:	• Basic concepts on chemistry of milk (eukaryotes and prokaryotes) • Basic engineering concepts on heat and mass transfers • 10 and 10+2 level mathematics
Course outcomes:*	After completion of this course, students will be able to • possess a comprehensive understanding on applications of microbiology and biotechnology in food sector. • earn a clear concept on fermented foods, foodborne diseases, and applications of biotechnology to advance food production, processing and quality. • have a clear overview on various different aspects of applications of microbiology, and biotechnology in food, and their relevance in human society and nature.

Unit/ Module no.	Topic	No. of contact hours
1	Introduction: Present status of milk and milk products as a food category in India and abroad; Chemical composition, nutritional and health benefits of milk and milk products; Legal definition of milk and colostrum in India Milk secretion: Structure and functions of mammary gland; Process of milk secretion	10

2	Fluid milk processing: Pasteurization, homogenization, clarification, milk standardization; Fluid milk packaging Processing of butter: Indian legal standards for cream and butter; Processing technology of butter and ghee	10
3	Fermented dairy product processing: Processing of yoghurt, *lassi*, acidophilus milk, cultured butter milk, kefir, koumiss Processing technology of cheese: Processing technology ripened cheese e.g., Cheddar, Swiss, Camembert, Limburger, and unripened cheese e.g., Mozzarella, *paneer*, and processed cheese	12
4	Processing technology of other milk products: Ice cream, milk powder, major traditional Indian dairy sweets (*khoa* and *chhana* based)	8

Text Book:

1. De, S. (2018). Outlines of Dairy Technology (44th Ed.). Oxford University Press
2. Bylund, G. (Ed) (2025). Dairy Processing Handbook. Tetra Pak Processing Systems

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE502
Course Title:	Food Process Engineering
Course Credit:	3 (L: 2 T:1 P: 0)
Course objective:	• Understand fundamentals of humidification, drying, filtration, evaporation, and crystallization relevant to food processing. • Analyze psychrometric properties of air and apply them in humidification and dehumidification operations. • Study moisture kinetics and its influence on food stability and drying design. • Examine industrial drying, evaporation, filtration, and crystallization systems used in food industries. • Develop problem-solving skills for design and performance evaluation of food process equipment.
Pre-requisites:	• Basics of Thermodynamics • Mass and Heat Transfer principles
Course outcomes:*	After completion of this course, students will be able to • Interpret psychrometric charts and humidification operations in food processing. • Explain moisture content characteristics, EMC, and their applications in drying system design. • Distinguish drying rate periods and calculate drying time. • Describe the working principles and classifications of dryers, evaporators, and filters. • Evaluate filtration mechanisms and analyze constant-rate vs. constant-pressure filtration. • Understand principles of crystallization and crystal growth in food product formation.

Unit/ Module no.	Topic	No. of contact hours
1	Humidification- General theory of humidification & dehumidification. Psychrometric chart: Uses and interpretation. Humidity terms: absolute, relative, specific humidity, humid heat. Cooling tower: types, operation, humidification efficiency. Applications in food processing (e.g., spray drying, storage air systems)	10
2	Moisture Content & Equilibrium- Moisture content: wet basis, dry basis. Types of moisture in foods (bound, free, equilibrium moisture). EMC: Concepts, determination methods. EMC models for food materials (Chung-Pfost, Henderson). Applications in drying and storage. Hysteresis effect in adsorption & desorption isotherms	8
3	Drying- Fundamental mechanism of drying. Heat & mass transfer in drying. Drying rate curves: *Constant Rate Period & Falling Rate Period(s).* Drying time estimation for different food materials Dryers: Tray dryer, tunnel dryer, rotary dryer, spray dryer, fluidized bed dryer, freeze dryer, drum dryer, Novel/Advanced dryers: microwave dryers, hybrid solar dryers	10
4	Evaporation- Principle and applications in food concentration. Feeding methods: forward feed, backward feed, mixed feed Types of evaporators: single & multi-effect evaporators, falling film, rising film, forced circulation. Performance evaluation: Economy, steam consumption.	06
5	Filtration- Principle of filtration in food industries, Constant Rate Filtration / Constant Pressure Filtration. Filter media, filter beds, Filter cake: properties, compressible vs incompressible. Filtration equipment: plate & frame filter press, rotary vacuum filter, membrane filters	04
6	Crystallization- Principle and supersaturation, Nucleation & Crystal Growth, Crystallization process in food products (e.g., sugar, salt, lactose). Types of crystallizers.	03

References and Text Books

1. *Singh, K.K. & Sahay, A.K.- Unit Operations of Agricultural Processing, (Latest Edition), Vikas Publishing House, New Delhi.*
2. *D. G. Rao (2010). Fundamentals of Food Engineering. PHI Learning Pvt. Ltd., New Delhi.*
3. *Akash Pare & B. L. Mandhyan, Food Process Engineering and Technology, Daya Publishing House / Astral International Pvt. Ltd., New Delhi.*
4. *R. P. Singh & D. R. Heldman – Introduction to Food Engineering (Indian edition available)*
5. *J. G. Brennan, J. R. Butters, N. D. Cowell, A. E. V. Lilly., Food Engineering Operations, Elsevier Applied Science*
6. *D. R. Heldman & R. P. Singh, Food Process Engineering, VI Publishing Company, Westport*
7. *Toledo, R. T. (2018). Fundamentals of Food Process Engineering (4th Edition), Springer, Cham.*
8. *McCabe, W. L., Smith, J. C., & Harriott, P. (2005). Unit Operations of Chemical Engineering (7th Edition). McGraw-Hill International Edition, New York.*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE503
Course Title:	Food Process Equipment Design
Course Credit:	3 (L: 3 T:0 P: 0)
Course objective:	• To understand the engineering properties of different materials for the development of food plant equipment. • To familiarize the students with the industrial processes involving material handling equipments, etc. • To provide the students with insight of various heat exchangers, freezers, extruders, their principles and equipments.
Pre-requisites:	• Fundamentals of heat and mass transfers • Introduction to Food Engineering
Course outcomes:*	After completion of this course, students will be able to • Understand and apply the engineering properties of materials used in the design and development of food processing equipment. • Demonstrate knowledge of industrial operations and the functioning of various material handling systems used in food industries. • Explain the principles, construction, and applications of major food process equipment such as heat exchangers, freezers, and extruders.

Unit/ Module no.	Topic	No. of contact hours
1	Materials and properties: Materials for fabrication, mechanical properties, ductility, hardness, corrosion, protective coatings, corrosion prevention linings equipment, choice of materials, Fabrication of Equipment, Hygienic Design of Food Processing Equipment, Selection of Food Processing Equipment.	10
2	Design of material handling equipment: Belt conveyor, Roll and Skate Wheel Conveyors, Chain Conveyors, Screw Conveyors, Vibratory Conveyors, pneumatic conveyor.	8

3	Design of heat exchangers: Double Pipe, Shell and tube, Plate and scraped surface heat exchanger (Design will include functional & structural design).	8
4	Freezing Equipment: Air Freezing Equipment, Tunnel Freezers, Fluidized Bed Freezers, Belt Freezers, Cold Surface Freezing, Liquid Freezing	7
5	Design of extruders: Cold Extrusion, Extrusion Cooking, Single Screw Extruders, Twin-Screw Extruders, Extrusion System Design	7

Text Books:

1. *R.P. Singh and D.R. Heldman (2009). Introduction to food engineering. Gulf Professional Publishing.*
2. *M. V. Joshi and V. V. Mahajani (1981). Process equipment design. Macmillan India Limited.*
3. *G. D. Saravacos and A.E. Kostaropoulos, (2002). Handbook of food processing equipment. Kluwer Academic/Plenum.*

Reference Books:

1. *R. H. Perry and C. H. Chilton (1997) Perry's Chemical Engineers' Handbook (7^{th} ed.), McGraw-Hill.*
2. *B. C. Bhattacharya (2015) India, Mechanical Design and Fabrication of Process Equipment, Khanna Publishers, Delhi*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE511
Course Title:	Food Industry Waste Management
Course Credit:	2 (L: 2 T:0 P: 0)
Course objective:	• To build better understanding of the nature and sources of waste generated from various sectors of food processing industry. • To impart knowledge on the characteristics of food processing wastes and their impact on the environment. • To learn various treatment processes of food industry effluents and solid waste and their final safe disposal methods. • To disseminate knowledge on the valorization of waste to convert them into valuable products. • To learn about the environmental regulations and standards for effluents and solid waste management.
Pre-requisites:	-
Course outcomes:*	After completion of this course, students will be able to • Origin and type of waste and by products, waste identification, classification, and composition. • Need for treatment and utilization. Impact of waste disposal on environment. • Food waste effluents treatments. • Solid food waste managements. • Legal and statutory requirements for food waste handling, treatment and disposal.

Unit/ Module no.	Topic	No. of contact hours
1	Introduction to Food Waste and Byproducts: Discuss food waste from a historic, regional, cultural, and socio-economic perspective, Classifications of the wastes, define key concepts, such as food loss and waste, avoidable and unavoidable waste,	6

	Identify the economic, social, and environmental challenges and opportunities related to food waste.	
2	Waste characterization and management: Physical, chemical and biological characteristics of wastewater. Standards for emission or discharge of environmental pollutants from food processing industries covered under EPA Act., 1986. Introduction to Waste management and waste management stages.	5
3	Treatment of food industry effluents: Preliminary treatments: Screening, comminution, grit removal, flow equalization, floatation; Primary treatments: sedimentation, coagulation and flocculation; Biological or secondary treatments: Working principle and design of lagoons, trickling filters, activated sludge process, oxidation ditches, rotating biological contractors, UASB and their variations and advanced modifications. Tertiary treatment of food industry effluents: Nitrogen removal, phosphorus removal, membrane process, etc. Treatment, disinfection, handling and disposal of sludge.	8
4	Solid Waste Treatment: Types and characteristics, Composting; aerobic and anaerobic, vermicomposting, Incineration, pyrolysis, and gasification, Landfill, Legal and statutory requirements for food waste handling, treatment and disposal.	6
5	Utilization of wastes: From grain processing industry, fruits and vegetables processing industry, fish, meat and poultry processing industry, dairy industry, sugar processing industry, spice processing industry and food fermentation processing industry.	5

Text Books:

1. *Syed E. Hasan; Introduction to Waste Management, Wiley 2022*
2. *V.K. Joshi & Satish Sharma; Food Processing Waste Management: Treatment and Utilization Technology.*

Reference Books:

1. *Water technology by N.F.Gray.*
2. *Environmental pollution by K.C.Agrawal.*
3. *Industrial microbiology by L.E.Casida Jr*
4. *Food processing waste management by green and Kramer (AVI)*
5. *By- products from food industries: utilization and disposal by AFSI(I)*

6. *Handbook of advanced wastewater treatment by Culp and Wisner.*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE512
Course Title:	Genetically Modified Foods
Course Credit:	2 (L: 2 T:0 P: 0)
Course objective:	• Understand the scientific principles behind genetic modification and the development of GM plants, animals, and microbes. • Familiarize with major commercial GM crops, transgenic animals, and micro-organisms along with their application in food and bioprocess industries. • Examine the methods used to establish and transfer foreign genes in plants, animals, and microbes. • Recognize biosafety concerns, ethical issues, and regulatory aspects related to GM foods and biotechnology.
Pre-requisites:	Biology for Engineers, Basic Microbiology, Food Microbiology and Biotechnology
Course outcomes:*	After completion of this course, students will be able to • Describe the advantages, traits, and transformation techniques used to produce herbicide-tolerant, nutritionally fortified, and stress-resistant GM plants. • Analyze commercial case studies such as Bt-corn, Golden Rice, FLAVR-SAVR tomato, transgenic fish, and GM microbes used in the production of beverages, edible vaccines, and functional oils. • Compare and evaluate different gene transfer methods used in plants, animals, and microbes for enhancing food quality, yield, and health benefits. • Critically assess risks associated with GM food such as allergenicity, antibiotic resistance, environmental effects, ethics of cloning, and interpret labeling and biosafety guidelines.

Unit/ Module no.	**Topic**	**No. of contact hours**

1	Introduction to GM foods- Advantages of GM foods-Herbicide tolerant crops-Frost resistance-Drought and Salinity resistance-Insect resistance – Virus resistance- Nutritional fortification, Methods of establishing- Genetically Modified Plants-Transformation Methods-Agrobacterium transformation and Direct gene transfer.	7
2	Transgenic Plants-Commercially available GM crops-Bacillus thuringiensis corn (StarLink corn)-Golden Rice-Fungal resistant Bintje Potatoes-Lectin Potato-Methionine enriched oil-Calgene FLAVR SAVR tomato-Chymosin Bovine Somatotrophin Lite Beer L-tryptophan-Indian Bt eegplant.	5
3	Creation of transgenic animals- Gene transfer in poultry-Gene transfer in fish-Transgenes-gene constructs-improved growth rate, carcass composition and feed efficiency-Transgenic mammalian farm animals-Transgenic fish-Atlantic Salmon-Bovine Somatotropin in Milk-alpha lactalbumin and lactoferrin in milk-Growth hormone genes in pig.	6
4	Genetically engineered bacteria-Genetically modified Saccharomyces strains-applications in Beer, wine's sake and bread, Beta carotene in rice-Transgenic 'heart-healthy' Canola oil -edible vaccines-Hepatitis B vaccine in maize-Cholera vaccine in potatoes.	5
5	Risk associated with GM foods-Allergens, toxins, antibiotic resistance, soil contamination- Creation of superbugs and superweeds-Increased risk of immune- suppression and cancer risks-Labelling GM foods-Ethics related to cloning-Biosafety and risk assessment.	5

Suggested Readings:

1. *Knutt J. Heller, 'Genetically engineered food-Methods and detection' Wiley-VCH, 2nd edition, 2006.*
2. *Colin Andre Carter et al., 'Genetically modified food and Global welfare' Frontiers of Economics and Globalization, Emerald Group Publishing Limited, 1st edition, 2011.*
3. *Stephen Nottingham 'Eat your genes: How genetically modified food is entering your diet Zed Books Ltd, 2nd edition, 2003.*
4. *Kung, Shain-Dow 'Biotechnology and Food Quality'-Butterworth, 1989.*
5. *Jerry Freedman, 'Genetically modified food'- How Biotechnology is changing what we eat' The Rosen Publishing Group, Inc., 1st edition, 2009.*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE513
Course Title:	Separation Technology
Course Credit:	2 (L: 2 T:0 P: 0)
Course objective:	• Develop a basic understanding of separation principles for different types of components in various systems. • Familiarize students with equilibrium-based separation methods and distillation for recovering valuable components from liquid and solid streams. • Introduce the fundamental theory and application of modern separation and purification processes.
Pre-requisites:	
Course outcomes:*	After completion of this course, students will be able to • Understand the fundamental principles governing separation of components in diverse systems. • Apply equilibrium-based and distillation techniques for efficient recovery and purification of valuable materials. • Analyze and evaluate modern separation and purification methods used in process industries.

Unit/ Module no.	**Topic**	**No. of contact hours**
1	Introduction to various separation processes; Gas-Liquid, Gas–Solid, Liquid-Liquid, Liquid-Solid separation; Concept of phase equilibrium, Stage equilibrium, Equilibrium concentration; Single stage contact equilibrium, counter-current multiple contact stages, Determination of optimum number of contact stages by analytical and graphical method.	6
2	Rate of extraction, Construction and working mechanism of different extraction equipments like single stage extraction,	6

	Multiple stage static bed system, Bollmann extractor, Hildebrandt extractor, Rotocell extractor.	
3	Solid Separation Process- Introduction, Concept of size, Shape, Cut-size, Sieving, Magnetic separation, Eddy-current separation, Wet separation, Ballistic separation, Color separation.	5
4	Liquid-solid and liquid- liquid separation by hydroclones, Surface velocity classifier, Elutriators, Impingement separator, Electrostatic precipitation; Super Critical Fluid Extraction: Introduction, Properties of SCFE, Application of SCFE	6
5	Advanced separation processes: Dialysis, ultrafiltration, reverse osmosis, pervaporation, electro dialysis and membrane separation.	5

Text Books:

1. *A.S. Grandison and M.J. Lewis (1996) England, Separation Process in the Food & Biotechnology Industries, Woodhead Publishing Ltd.*
2. *C. M. Narayanan and B. C. Bhattacharyya (2012) India, Mechanical Operations for Chemical Engineers, Khanna Publishers, New Delhi*

Reference Books:

1. *B. K. Dutta (2007) India, Mass Transfer & Separation Process, Prentice-Hall of India Pvt. Ltd., New Delhi.*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UME571
Course Title:	Fluid and Thermal Engineering Lab
Course Credit:	1 (L: 0 T:0 P: 2)
Course objective:	• To understand the principles and performance characteristics of fluid flow devices. • To learn the fundamental measurement techniques of heat transfer parameters. • To study and evaluate the performance of mass transfer operations such as evaporation and solid–liquid extraction.
Pre-requisites:	-
Course outcomes:*	After completion of this course, students will be able to • Measure and analyse flow characteristics and fluid properties such as flow rate, velocity and coefficient of discharge. • Evaluate head losses in a pipe flow. • Evaluate the performance of fluid machinery and heat transfer equipment such as pumps and heat exchangers. • Measure the heat transfer rate due to different modes of heat transfer. • Perform liquid–liquid and solid–liquid extraction by evaporation, and extraction processes.

Sl. No.	**Name of the Experiment**	**No. of contact hours**
1	Verification of Bernoulli's equation experimentally.	2
2	Determination of the coefficient of discharge for the Venturimeter and Orifice meter.	2

3	Determination of the velocity of fluid at any point in a pipe by the Pitot-tube.	2
4	Estimation of the minor losses due to bends, elbows, sudden enlargement, and sudden contraction in a pipe.	2
5	Study of Reynolds number in different flow conditions.	2
6	Determination of the performance characteristics of a centrifugal pump.	2
7	Determination of thermal conductivity of the given insulating material and composite walls.	2
8	Determination of overall heat transfer coefficient in parallel/counter flow arrangements of a concentric tubular, and shell and tube heat exchangers	2
9	Determination of the overall heat transfer coefficient of a plate-type heat exchanger.	2
10	Study of Stefan– Boltzmann's apparatus.	2
11	Performance evaluation of a rotary vacuum evaporator.	2
12	Study of solid–liquid extraction process using Soxhlet apparatus / packed bed.	2

Reference Books:

1. *Som, S.K., Biswas, G. and Chakrabarty, S., Introduction to Fluid Mechanics and Fluid Machines, McGraw-Hill, 3rd Edition, 2017.*
2. *Bansal, R.K., A Text Book of Fluid Mechanics, Laxmi Publications, 2nd Edition, 2020.*
3. *Bergman T. L., Lavine, A.S., Incropera P.F., and DeWitt, D.P., Fundamentals of Heat and Mass Transfer. John Wiley, 8th edition, 2018.*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE571
Course Title:	Product Technology-III Lab
Course Credit:	1 (L: 0 T:0 P: 2)
Course objective:	• To impart hands-on training on methods to evaluate the physicochemical and nutritional quality of milk. • To develop skills for performing rapid quality tests and detecting adulteration in milk and milk products. • To provide practical exposure to preparation of traditional Indian dairy products and evaluation of their quality. • To cultivate analytical ability to compare laboratory-prepared products with commercial counterparts based on quality attributes.
Pre-requisites:	-
Course outcomes:*	After completion of this course, students will be able to • Perform standard tests to determine nutritional composition, acidity, SNF, specific gravity and microbial activity in milk. • Assess the quality of milk through COB, alcohol and related chemical tests, and interpret the results scientifically. • Detect common adulterants in milk and milk products using validated analytical techniques. • Prepare kalakand, paneer, rasgulla ,mishti dahi and lassi in the laboratory and compare their quality with market samples on defined parameters.

Sl. No.	Name of the Experiment	No. of contact hours
1	To analyze the nutritional composition of milk.	2

2	Determination of COB test, alcohol test, total solids in milk	2
3	Determination of specific gravity, SNF, acidity and pH of milk.	2
4	To determine the metabolic activity of bacteria in milk and determine the quality of milk.	2
5	Detection of adulteration of milk and milk products.	2
6	To prepare kalakand from milk and compare the quality with market product.	2
7	To prepare paneer from milk and compare the quality with market product.	2
8	To prepare rasgulla from milk and compare the quality with market product.	2
9	To prepare mishti dahi from milk and compare the quality with market product.	2
10	To prepare lassi from milk and compare the quality with market product.	2

Text Books:

1. *H. Richmond, Droop (2004). Laboratory Manual of Dairy Analysis. Revised edition. Biotech Books.*
2. *N. Garg, K. L. Garg, K. G. Mukerji (2010). Laboratory Manual of Food Microbiology. I.K. International Pvt Ltd.*

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE572
Course Title:	Food Engineering Lab
Course Credit:	1 (L: 0 T:0 P: 2)
Course objective:	• To impart practical understanding of psychrometric principles and determination of air–vapor properties under different conditions. • To familiarize students with food dehydration behaviour and determination of drying kinetics using different industrial dryers. • To develop hands-on skills in measuring equilibrium moisture content and analysing its influence on drying and storage. • To introduce evaporation and filtration operations using pilot-scale equipment and evaluate their operating performance.
Pre-requisites:	-
Course outcomes:*	After completion of this course, students will be able to • Calculate psychrometric properties of air–water–vapor mixtures and analyze the effect of air mixing using the psychrometric chart. • Measure equilibrium moisture content and generate drying curves to interpret drying behaviour of food materials. • Determine drying rate in tray, vacuum, rotary and freeze dryers and compare performance under varying operating conditions. • Perform evaporation and filtration experiments (Calandria, rotary vacuum evaporator, plate & frame, rotary drum filter) and interpret operational results quantitatively.

Sl. No.	**Name of the Experiment**	**No. of contact hours**

1	To study the following using Psychrometric Chart: i. Determination of various properties of air–water–vapor mixture from any two given parameters (RH, WBT, DBT, DPT). ii. Determination of various properties of air–water–vapor mixture obtained after mixing of two different air streams having different properties.	2
2	To determine the Equilibrium Moisture Content (EMC) of given food materials using the static equilibrium method.	2
3	To study the dehydration characteristics of fruits and vegetables by obtaining: i. Moisture content vs. time curve, ii. Drying rate vs. time curve.	2
4	To determine the rate of drying for given food products/samples using tray dryer and vacuum dryer	2
5	To determine the rate of drying in a rotary dryer for different air flow rates and air inlet temperatures.	2
6	To study the operation of the freeze drying process.	2
7	To concentrate sodium carbonate solution using a Calandria Evaporator.	2
8	To concentrate sodium chloride solution using a Rotary Vacuum Evaporator	2
9	To study the operation of a Plate and Frame Filter Press.	2
10	To study the performance of a Rotary Drum Filter operation under vacuum	2

Name of the Programme:	B. Tech
Semester:	5
Course Code:	UFE573
Course Title:	Process Equipment drawing
Course Credit:	1 (L: 0 T:0 P: 2)
Course objective:	• Understand fundamental design parameters and geometrical considerations of common food processing equipment. • Develop proficiency in drawing process equipment such as heat exchangers, evaporators, reactors, dryers, boilers and valves using given dimensions. • Correlate engineering design features with functional requirements and operating principles of thermal and mechanical food process units. • Cultivate drafting accuracy, technical neatness and interpretation skills necessary for industrial technical documentation.
Pre-requisites:	-
Course outcomes:*	After completion of this course, students will be able to • Interpret given design data and generate precise technical drawings of heat transfer and reaction equipment such as shell-and-tube exchangers and reaction vessels. • Construct scaled layouts and sectional designs of evaporators, boilers, steam kettles and autoclaves based on process dimensions. • Develop detailed engineering sketches of process–mechanical components such as dryers and valves, meeting industrial drawing conventions. • Evaluate and present equipment designs with appropriate annotations, accuracy and conformity to standard process-engineering drawing norms.

Sl. No.	Name of the Experiment	No. of contact hours
1	Draw the symbols of each of the equipment used in industries.	2
2	Draw the piping symbols used in industry.	2
3	Draw the design of shell and tube heat exchanger.	2
4	Draw the design of double pipe heat exchanger.	2
5	Draw the design of dynamic scraped surface heat exchanger.	2
6	Draw the design of plate heat exchanger.	2
7	Draw the design of tunnel freezer.	2
8	Draw the design of fluidized bed freezer.	2
9	Draw the design of single screw and twin screw extruder.	2
10	Draw the design of different type conveyors used for material transportation.	2

Text Books & Reference Books:

1. *Maidargi, C. Suresh. (2015). Chemical Process Equipment: Design and Drawing (Volume I), Sec. PHI Learning Pvt. Ltd.*
2. *Thulukkanam, Kuppan. (2013). Heat Exchanger Design Handbook. (2nd ed). CRC Press (Taylor & Francis Group).*

Proposed Courses from 4th Semester

5th Semester								
Sl No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**	**CONTACT HOURS**	**Coordinating Department**
1	UHS501	Industrial Management & Entrepreneurship	3	0	0	3	3	HSS
2	UIE501	Microprocessor & Microcontroller	3	0	0	3	3	IE
3	UIE502	Control Systems	3	0	0	3	3	IE
4	UIE503	Industrial Instrumentation	3	0	0	3	3	IE
	UIE511	Data Structures using C	3	0	0	3	3	CSE
	UIE512	Digital Signal Processing						IE
5	UIE513	Optimization techniques						IE
6	UIE571	Microprocessor & Microcontroller Lab	0	0	2	1	2	IE
7	UIE572	Control Systems Lab	0	0	2	1	2	IE
8	UIE573	Industrial Instrumentation Lab	0	0	2	1	2	IE
9	UIE574	Signals and Systems Lab	0	0	2	1	2	IE
		TOTAL	**15**	**0**	**8**	**19**	23	

Detailed Course Contents of 5th Semester

Paper code: UIE501 **Paper name: Microprocessor & Microcontroller**

Credit: 3 **Total contact hours: 36** **L-T-P: 3-0-0**

Course Objectives

1. Understanding Microprocessor Architecture: Introduce students to the fundamental concepts of computer architecture and organization with a focus on 8-bit microprocessors.
2. Proficiency in Assembly Language: Develop skills in assembly language programming and understanding machine language instructions.
3. Comprehending Memory Technologies: Provide a thorough understanding of various memory technologies, memory interfacing, and peripheral interface chips.
4. Mastering Data Transfer Techniques: Equip students with knowledge about different data transfer schemes, including serial and parallel, and understanding interrupts and DMA controllers.
5. Exploring Microcontroller Systems: Familiarize students with the architecture, instruction sets, and programming of the 8051 microcontroller, and the principles of embedded system design.

Course Outcomes

1. Understanding of Microprocessor Architecture:
    - Students will be able to describe the architecture and organization of 8-bit microprocessors, including CPU modules and bus configurations.
    - Students will demonstrate knowledge of subroutines, stacks, and the instruction set of typical 8-bit microprocessors through programming exercises.
2. Proficiency in Assembly and Machine Language Programming:
    - Students will gain proficiency in writing and debugging assembly language programs.
    - Students will be able to explain and apply machine language instructions in practical programming exercises.
3. Comprehending Memory Technologies:
    - Students will be able to interpret timing diagrams and understand different memory families.
    - Students will demonstrate the ability to interface memory and peripheral chips, and program input-output ports and interval timers.
4. Mastering Data Transfer Techniques:
    - Students will understand and differentiate between serial and parallel data transfer schemes.

- Students will be able to implement interrupt service procedures and understand the role of programmable interrupt and DMA controllers.

5. Exploring Microcontroller Systems:
    - Students will be able to describe the architecture and bus configuration of the 8051 microcontroller.
    - Students will develop and troubleshoot embedded system software and hardware, utilizing development tools effectively.

Module 1: Introduction to computer architecture and organization
Contact Hours: 12

Introduction to computer architecture and organization: Architecture of 8-bit microprocessor, Bus configurations, CPU module, Addressing modes and instruction set of 8085, Introduction to assembly language and machine language programming, Subroutines and stacks, Programming exercises.

Module 2: Memory technology
Contact Hours: 10

Timing diagrams, Memory families, Memory interfacing, Programmable peripheral interface chips, Interfacing of input-output ports, Programmable interval timer.

Module 3: Data transfer schemes
Contact Hours: 8

Serial and parallel data transfer schemes, Interrupts in 8085, Interrupt service procedure (ISR), Programmable interrupt controller, Direct memory access (DMA), Programming exercises.

Module 4: Architectures of 8051 Microcontroller
Contact Hours: 6

Introduction to 8051 microcontroller family, Bus configuration, Instruction sets, Programming exercises. Embedded system concepts and hardware design, Overview of embedded software development cycles.

Text Books:

1. Gaonkar, Ramesh S. Microprocessor Architecture, Programming, and Applications with the 8085. Sixth edition, Penram International Publishing (India) Pvt. Ltd., 2013.
2. Mazidi, Muhammad, et al. The 8051 Microcontroller and Embedded Systems. Second edition, Pearson, 2013.
3. Hall, Douglas V., and S. S. S. P. Rao. Microprocessors and Interfacing. Third special Indian edition, Tata McGraw-Hill, 2012.

4. Chaudhury, S., and Risha Mal. Microprocessor and Microcontroller. First edition, All India Council for Technical Education (AICTE), New Delhi, March 2023.

Reference Books:

1. Ram, B. Fundamentals of Microprocessors and Microcontrollers. Dhanpat Rai Publications (P) Ltd., 2012.

2. Gupta, Yogendra Kumar. Microprocessors. First edition, All India Council for Technical Education (AICTE), 2021.

Subject: Control System

Course code: UIE502

L-T-P: 3-0-0

Course Objectives:

1. To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.
2. To employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system
3. Formulate different types of analysis in frequency domain to explain the nature of stability of the system.
4. To analyze and design controllers to meet stability and performance requirements.

Module I: Introduction and overview:

Define the Control problem with examples. Meaning of reference input, Control input, disturbance input and controlled output.

Module II: Modeling:

Define Linear Time variant system. Modeling problem for linear time invariant system. Impulse response and convolution integral for LTI system. Transfer function modeling of systems: Input output relation in Laplace domain and Transfer function; Block Diagram reduction, signal flow graph, Mason's Gain theorem. Representation of system and reduction to their transfer function. Modeling of some physical system--- Electrical circuit, Mechanical motors, thermal (room temperature), pneumatic etc. Concepts of States, State space modeling, Solution of state equations, State space to transfer function, transfer function to state space (realization problem). Examples of state space modeling---- Coupled tank system, inverted pendulum, biological system etc.

Module III: Characterization of Plant:

Definition of stability. Criteria for stability of a system. Pole-zero concept, Routh-Hurwitz Criterion, Eigen value. Equivalence of pole and Eigen value. Time domain: Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. Frequency-domain: Meaning of frequency response, Analytical evaluation of Frequency response of given transfer function. Polar plots, Bode plots and Nyquist plot for representation of frequency response. Gain cross over frequency, phase cross over frequency. Role off rate. DC gain, corner frequency.

Module IV: Characterization of feedback loop:

Advantages of feedback. Loop Stability: Bode and Nyquist plot criteria. Bode stability criteria, Nyquist stability criteria, loop robustness, gain margin, phase margin, delay margin. Loop performance: Frequency domain parameter sensitivity, tracking, disturbance rejection. Loop performance in time domain: Transient response: Root locus, Steady state response: Steady state error.

Module V: Controller Design problem:

PID Control. Frequency domain Loop shaping approach: Lead, Lag, Lag-lead compensator. Model matching approach: Two degree of freedom controller. State feedback approach: Controllability, Observability, Pole placement, State Observer.

Module VI: Introduction to Optimal Control and Nonlinear Control:

Nonlinear Control: Linearization about operating points. Optical Control: Performance Indices and their optimization. LQR problem.

Text/References:

1. Automatic Control System: Basic analysis and design by William A. Wolovich, The Oxford Series in Electrical and Computer Engineering.

2. B. C. Kuo, “Automatic Control System”, 10th Mc Graw Hill.

3. K. Ogata, “Modern Control Engineering”, Prentice Hall, 5th edition.

4. I. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009

5. Control Systems Engineering, 6th edition, ISV (WSE), by Norman Nise, Wiley

6. Control Systems, Ambikapathy, Khanna Publishing House, 2018.

7. Control Systems, N K Sinha, New Age International Pvt, 2013.

Course Outcomes: At the end of this course, students will understand

1. The modeling of linear-time-invariant systems using transfer function and state-space representations.

2. The concept of stability and its assessment for linear-time invariant systems.

3. Characterization of plants and control loops.

4. The need for compensation, & the methods used for compensation techniques.

5. Linearization of non-linear system

6. Performance indices for optimal control.

UIE503: Industrial Instrumentation L T P: 3 0 0 Credit Points: 3

Course Objectives:

1. To familiarize about the different industrial process instruments
2. To explain the operations and constructions of different industrial process instruments
3. To utilize the different industrial process instruments

Course Outcomes (CO):

After completion of the course, the students will be able to

1. interpret the conceptual framework on different industrial process parameters like temperature, pressure, flow and level
2. demonstrate the operations of different industrial process instruments
3. utilize and recommend the different industrial instruments
4. examine the importance of the different industrial instruments

Module 1: Temperature Measurement

Fundamentals, filled in system - liquid, gas and vapour; thermostat, resistance temperature detector, thermistor, thermocouples and cold junction compensation (CJC) & methods.
Radiation Thermometer and Optical Pyrometers

Module 2: Pressure Measurement

Fundamentals, Manometers – U type, well type and inclined type; elastic type pressure measuring instruments – Bourdon tube, diaphragms, bellows and capsules; differential pressure gauge and DP Transmitter – capacitive type.
Vacuum measurement – Mcleod gauge, thermal conductivity gauge and ionization gauge

Module 3: Flow Measurement

Fundamentals, head type flow meters - venturi, orifice, flow nozzle and Pitot tube; Area type flow meters – rotameter, Positive displacement flow meter, vortex flow meter (VFM), electromagnetic flow meter, ultrasonic flow meter, turbine flow meter, coriolis mass flow meter and thermal flow meter. Open channel flow meters.

Module 4: Level Measurement

Fundamentals, Float and displacer type , Purge or Bubbler method, Gauge glass, Bi-color, Magnetic type level gauge, Capacitive level gauge, Ultrasonic level gauge, Nucleonic level gauge and Microwave type level gauge.

Module 5: Others

Pneumatic instrumentation, flapper nozzle, Pneumatic transmitter, Pressure to current converter (PIC) and current to Pressure to converter (IPC).

Text Books

1 D. Patranabis – Industrial Instrumentation
2 A.K. Sawhney - A Course in Electrical & Electronic Measurement and Insrumentation
3 A K Ghosh - Principles of Instrumentation and Measurements
4 Nakra & Chowdhury – Instrumentation Measurement and Analysis

Reference Books

1 E.A. Doebelin - Measurement Systems : Applications and Design
2 V G Liptak – Instruments Engineers Handbook Vol I
3 John P. Bentley - Principles of Measurement Systems
4 Rangan, Sharma & Mani – Instrumentation: Devices & Systems
5 D P Eckman – Industrial Instrumentation

Paper Code: UIE511 Paper Name: DIGITAL SIGNAL PROCESSING

Credit: 3 Total contact hours: 36 L-T-P: 3-0-0

Course Objectives:

1. To describe signals mathematically and understand how to perform mathematical operations on signals.
2. It will provide knowledge of Digital filter.
3. To discuss word length issues multi-rate signal processing and application.
4. Concept of DSP Processor

Course Outcomes:

1. After the completion of the course the student will be able to :
2. Illustrate digital signals, systems and their significance.
3. Analyse the digital signals using various digital transforms DFT, FFT etc.
4. Design and develop the basic digital system.
5. Interpret the finite word length effects on functioning of digital filters.

6. Able to understand application DSP processor.

Module 1: Introduction: Introduction to Digital Signal Processing: Discrete time signals & sequences, linear shift invariant systems, stability, and causality. Linear constant coefficient differenceequations. Frequency domain representation of discrete time signals and systems.Discrete Fourier Series: Properties of discrete Fourier series, DFS representation of periodicsequences, Discrete Fourier transforms: Properties of DFT, linear convolution of sequencesusing DFT, Computation of DFT.

Module 2: Fast Fourier Transforms: Fast Fourier transforms (FFT) - Radix-2 decimation in time anddecimation in frequency, FFT Algorithms, Inverse FFT, FFT with General Radix.Realization of Digital Filters: Applications of z-transforms, solution of difference equationsof digital filters. System function, stability criterion, frequency response of stable systems.Realization of digital filters – direct, canonic, cascade and parallel forms, Lattice structures.

Module 3: IIR Digital Filters: Analog filter approximations – Butter worth and Chebshev, Design ofIIR Digital filters from analog filters, Bilinear transformation method, step and impulse invariance techniques, Spectral transformations.

Module 4: FIR Digital Filters: Characteristics of FIR Digital Filters, frequency response. Design of FIRDigital Filters using Window Techniques, Frequency Sampling technique, Comparison of IIR & FIR filters.

Module 5**: FIR and IIR Filter structures**. Structure for the realization of Discrete-time System, Canonic and non-canonic structures, The Basic Building Blocks, The Basic IIR Digital Filter Structures, Direct form I, Direct form II, Cascade Realization of IIR System, Parallel-Form Structures, Lattice Structures for IIR System (Reversible System), Signal Flow Graph and Transpose Structures, Basic FIR Digital Filter Structures, Direct Forms, Frequency –Sampling Structure, Lattice FIR Filter Structure

Module 6: Finite word length effects: Rounding and Truncation Errors, Quantization Effects in Analog to Digital Conversion, Limit Cycle Oscillations, Zero Input Limit Cycles, Overflow Limit Cycles.

Module 7: Multirate Digital Signal Processing: Decimation, interpolation, sampling rate conversion, filter design and implementation for sampling rate conversion.

Module 8: Introduction to DSP Processors: Introduction to programmable DSPs: Multiplier andMultiplier Accumulator (MAC), Modified Bus Structures and Memory Access schemes inDSPs Multiple access memory, Multiport memory, VLSI Architecture, Pipelining, Specialaddressing modes, On-Chip Peripherals. Examples: Features of TMS 320CXX Processors,Internal Architecture, External memory accesses, Pipeline operations, Peripherals.

Text Books:

1. Digital Signal Processing: Principals, Algorithms and Applications - Proakis, J.Gard and D.G.Manolakis, 3rd Edn.,,PHI, 1996.
2. Fundamentals of Digital Signal Processing – Robert J. Schilling & Sandra L. Harris, Thomson, 2005.

References:
1. Discrete Time Signal Processing – A.V. Oppenheim and R.W. Schaffer, PHI, 1989.
2. Fundamentals of Digital Signal Processing – LoneyLuderman.
3. Digital Signal Processing – S. Salivahanan et al., TMH, 2000.
Digital Signal Processing – Thomas J. Cavicchi, WSE, John Wiley, 2004.
4. Digital Signal Processors, Architecture, Programming & Applications, - B. Venkata Ramani, M.Bhaskar, TMH, 4th reprint, 2004.

Course Title: Optimization Techniques
Course Code: UIE513 **Credit: 03**
Total contact hours: 36 **L-T-P: 3-0-0**

Course Objective:

1. To provide the fundamental concepts of optimization starting from problem formulation to its solution.
2. To introduce the classical and modern optimization methods for constrained and unconstrained problems.
3. To develop the ability to resolve real-world engineering and management problems by proper modelling.

Course Contents:

Module 1 **Contact hours: 5**

Introduction to optimization, Revisit to the functions of single and multiple variables, Classification of optimization problems, formulation of optimization problems,. Overview of classical and modern optimization methods, Basics of linear and nonlinear programming.

Module 2 **Contact hours: 6**

Unconstrained problems: Definitions and Optimization criteria, General properties of minimization algorithms, Line search, The Steepest-Descent Optimization Technique, Newton's method, The Least-p^{th} Optimization Technique- Least square Algorithm.

Module 3 **Contact hours: 6**

Constrained optimization: Active and Inactive constraints, Transformations, penalty functions, Quadratic Approximation Methods for Constrained Problems, multistage optimization problem. Multi-objective and goal programming: problem formulation, solution of a multi-objective problem.

Module 4 **Contact hours: 9**

Stochastic Optimization Techniques: Introduction, types, Local and Global Search techniques,

Introduction to nature inspired optimization techniques, Introduction to Genetic Algorithms (GA), Working Principle of GA, Combined Genetic Algorithm, Advanced Genetic Algorithms, Differential Evolution, Applications.

Module 5: **Contact hours: 10**

Modern Optimization techniques, Ant Colony Optimization (ACO): Introduction, Ant Colony System, ANTS, Key Problems, Convergence Proofs. Discrete Particle Swarm Optimization (PSO): Introduction, PSO Elements: Position and State Space, Objective Function, Velocity, PSO Algorithm, Grey Wolf Optimizer, Whale Optimization algorithm, Use of Deep Learning Algorithm, Applications.

Text Books:

1. C. Mohan C and K. Deep, Optimization Techniques, New Age Science International Publisher, 2009,
2. Richard W Daniels, An Introduction to Numerical Methods and Optimization Techniques, Elsevier North Holland Inc,, 1978.
3. Milani Mitchel, An introduction to Genetic algorithms, MIT Press, 1998
4. AE Eiben and J.E Smith, Introduction to Evolutionary Computing, Springer 2010

Reference Books

1. S Rajasekharan, G.A Vijaya Lakshmi Pai, Neural Networks, Fuzzy logic, and Genetic algorithms, Synthesis and Applications, Prentice hall of India, 2007
2. Weifan Wang, Xuding Zhu, Ding-Zhu Du, Combinatorial Optimization and Applications:5th International Conference, Springer Publications, 2011.

Course Outcome:

After completion of this course, the students would be able to:

1. Understand the fundamental concepts of optimization algorithms
2. Learn to select appropriate optimization algorithms for a given application
3. Explain and utilize the nature inspired optimization techniques for its application in process control and industrial problems.

UIE571:-Microprocessor and Microcontroller Lab Credits: 01 L-T-P: 0-0-1

Course Objectives

- To familiarize students with the architecture, instruction set, and basic operations of the 8085 microprocessor and 8051 microcontroller.
- To develop skills in writing and debugging assembly language programs for arithmetic, logical, and control operations.
- To understand and implement data transfer, data conversion, and interfacing techniques using peripheral devices like 8155, 8255, 8279, ADC, and DAC.
- To impart hands-on experience in interfacing hardware components such as LEDs, keyboards, and displays with microprocessor and microcontroller kits.
- To enable students to design and execute embedded system applications using 8051 microcontroller and Embedded C programming.

Course Outcomes

After completing this lab, students will be able to:

- Demonstrate understanding of 8085 and 8051 architecture and perform basic operations such as register/memory data manipulation and instruction execution.
- Develop and test assembly language programs for arithmetic, logical, branching, and subroutine operations on 8085.
- Apply interfacing concepts to connect and control peripherals such as 8255 PPI, 8279 keyboard/display, ADC, and DAC.
- Analyze and implement data transfer, data conversion, and signal generation applications using microprocessor/microcontroller kits.
- Design small-scale embedded control systems using 8051 microcontroller, integrating hardware and software for real-time applications.

Laboratory Experiments

The laboratory exercises are designed to provide hands-on experience in programming and interfacing using microprocessor and microcontroller kits. The experiments to be performed will primarily focus on the following thematic areas:

1. **Introduction to the 8085 Processor Kit (Dyna-85L):** Familiarization with the kit operations including display and editing of register/memory data, and execution of instructions.

2. **Data Transfer Instructions:** Implementation of load and store operations using two-byte and three-byte instructions, immediate/direct/indirect addressing modes, and block data transfer techniques.
3. **Logical Instructions:** Execution of logical operations such as AND, OR, and XOR; nibble masking; accumulator manipulation; and rotation instructions.
4. **Arithmetic Instructions:** Development of programs for two-byte addition, subtraction, multiplication, and division with carry/borrow, as well as multi-byte and 16-bit arithmetic operations.
5. **Jump and Call Instructions:** Study and implementation of flag register concepts, conditional and unconditional jumps, subroutine calls, and return operations.
6. **Comparison Instructions:** Programs for comparing data values, identifying minimum/maximum elements in an array, sorting in ascending/descending order, and searching for specific data.
7. **Stack Pointer Handling:** Understanding stack operations and implementing jump, call, and return instructions involving stack manipulation.
8. **Data Conversion:** Conversion between various data formats such as BCD, binary, and ASCII.
9. **Interfacing Experiments:** Interfacing of peripheral devices including 8155, 8255, and 8279; generation of time delays and square waves of varying frequency/duty cycle; LED counters; keyboard input (4×4 matrix); and ADC/DAC interfacing.
10. **8051 Microcontroller:** Introduction to 8051 architecture, instruction set, data types, register bank selection, programming in Embedded C, loop/jump/call operations, port handling, and peripheral interfacing.

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Subject: Control System Laboratory **Course code: UIE572**

L-T-P: 0-0-2 **Credits: 01** **Contact Hours: 24**

Course Objectives:

1. To develop practical skills in system modeling, analysis, and control design, enabling students to understand and improve system performance in both time and frequency domains.
2. To analyze system stability, design controllers and compensators, and gain hands-on experience with control components and simulation software.

Course Outcomes:

1. Build in depth knowledge on MATLAB software
2. Analyze the concept of time response and frequency response of the systems
3. Design controllers, compensators using MATLAB software and examine their performances
4. Compare theoretical predictions with experimental results and attempt to resolve any apparent
5. differences

Sl. No.	Name of the Experiment
1	Familiarization with MATLAB control system tool box, MATLAB simulink tool box
2	Obtain the Velocity Response of physical system i.e Mass, Spring, Damper System Using MATLAB Command.
3	Reduction of the Block Diagram Using MATLAB Command and obtain the overall transfer function and verification of the results using theoretical calculations.
4	Develop step and impulse responses of a linear first-order systems and calculation of control system specification like Time constant, % peak overshoot, settling time etc. from the response.
5	Develop step and impulse responses of a linear second-order system and calculation of control system specification like Time constant, % peak overshoot, settling time etc. from the response.
6	Illustrate steady state errors for a type '0', type '1', type '2' systems
7	Construct Root locus plot of a second-order system using MATLAB
8	Experiment with Bode plot of a second-order system using MATLAB
9	Construct Nyquist plot of a second-order system using MATLAB
10	Examine the effect of a forward-path lead compensator of a linear feedback control system
11	Analyze the effect of addition of poles and zeros to the forward path transfer function of a closed loop system
12	Determination of PI, PD and PID controller action of first order simulated process.

Reference Books:

1. Matlab & Simulink for Engineers, Agam Kumar Tyagt, Oxford
2. Modeling & Simulatrion using Matlab-Similink, Dr. S. Jain, Wiley India
3. Matlab & its application in Engineering, Raj K Bansal, A.K. Goel & M.K. Sharma, Pearson
4. MATLAB programming for Engineers, S.J. Chapman, 3rd Edition, Cengage.

Subject: Industrial Instrumentation Laboratory **Course code: UIE573**

L-T-P: 0-0-2 **Credits: 01** **Contact Hours: 24**

Course Objectives:

1. Cultivate the ability to troubleshoot, maintain, and verify safe operation of industrial instruments according to standards and procedures.

2. Develop skills to set up, calibrate, and test industrial instrumentation devices used for pressure, flow, temperature, level, and other process variables.
3. Familiarize students with industrial signal conditioning circuits, data acquisition systems, and process control elements.
4. Enable students to analyze instrument performance, measurement accuracy, and error sources in practical industrial scenarios.

List of Experiments:

1. Temperature setup design by using RTD.
2. Temperature setup design by using Thermistor.
3. Temperature setup design by using Thermocouple.
4. Calibration/Error factor analysis of Bourdon Gauge by using Dead Weight Tester/ Comparison Gauge Tester.
5. Calibration of U-tube Manometers against applied pressure.
6. Calibration of Electronics Pressure sensor against applied pressure.
7. Calibration of Rotameter against flow-rate.
8. Calibration of flow rate against stem position of Control Valve.
9. Calibration of Capacitive sensor against liquid level.
10. Calibration of Pressure to current converter (PIC)/current to Pressure to converter (IPC).

Course Outcomes: After completion of the course, students will be able to

1. Identify and operate various industrial sensors and transducers used for measuring temperature, pressure, flow, and level.

2. Perform calibration procedures for industrial instruments such as pressure gauges, thermocouples, RTDs, flow meters, and level sensors.

3. Set up and test signal conditioning circuits including amplifiers, filters, bridges, and transmitters commonly used in industrial instrumentation.

4. Analyze measurement data and estimate error, accuracy, and repeatability for different process variables.

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Paper Code: UIE574 **Paper Name: Signals and Systems Lab**
Credit: 1 **Total contact hours: 24** **L-T-P: 0-0-2**

Couse Objectives:

The objectives of a Signals and Systems Lab are to help students understand and analyse various signals and systems through practical experience.
Key objectives include learning to classify signals, performing mathematical operations like convolution and Fourier transforms, designing and analysing filters, and understanding concepts like sampling and system properties such as linearity and time-invariance. The lab typically focuses on using software like MATLAB to simulate and verify these theoretical concepts.

1. Understand and analyse signals: Classify, represent, and perform operations on continuous and discrete-time signals.
2. Master system analysis: Understand and verify properties of systems, such as linearity, time-invariance, and stability.
3. Perform time and frequency domain analysis: Use mathematical tools like the Fourier Transform, Discrete Fourier Transform (DFT), and Laplace Transform to analyse signals and systems.
4. Design and analyse filters: Learn to design and analyse the response of filters like Low-Pass Filters (LPF) and High-Pass Filters (HPF).
5. Understand sampling: The principles of sampling and reconstruction and their impact on signals.
6. Implement operations: Apply concepts like convolution, correlation, and other signal processing operations through simulation.

LIST OF EXPERIMENTS:

1. Introduction to MATLAB
   a. To define and use variables and functions in MATLAB.
   b. To define and use Vectors and Matrices in MATLAB.
   c. To study various MATLAB arithmetic operators and mathematical functions.
   d. To create and use m-files.

2. Basic plotting of signals
   a. To study various MATLAB commands for creating two and three dimensional plots.
   b. Write a MATLAB program to plot the following continuous time and discrete time signals.
      i. Step Function
      ii. Impulse Function
      iii. Exponential Function
      iv. Ramp Function
      v. Sine Function
3. Time and Amplitude transformations Write
   a. MATLAB program to perform amplitude-scaling, time-scaling and time shifting on a given signal.
4. Convolution of given signals. Write a MATLAB program to obtain linear convolution of the given sequences.
5. Autocorrelation and Cross-correlation
   a. Write a MATLAB program to compute autocorrelation of a sequence x(n) and verify the property.
   b. Write a MATLAB program to compute cross-correlation of sequences x(n) and y(n) and verify the property.
6. Fourier Series and Gibbs Phenomenon
   a. To calculate Fourier series coefficients associated with Square Wave.
   b. To Sum the first 10 terms and plot the Fourier series as a function of time.
   c. To Sum the first 50 terms and plot the Fourier series as a function of time.

7. Calculating transforms using MATLAB
   a. Calculate and plot Fourier transform of a given signal.
   b. Calculate and plot Z-transform of a given signal.
8. Impulse response and Step response of a given system
   a. Write a MATLAB program to find the impulse response and step response of a system form its difference equation.
   b. Compute and plot the response of a given system to a given input.
9. Pole-zero diagram and bode diagram
   a. Write a MATLAB program to find pole-zero diagram, bode diagram of a given system from the given system function.
   b. Write a MATLAB program to find, bode diagram of a given system from the given system function.
10. Checking Linearity/Non-Linearity of a system using SIMULINK.

DOs and DON'Ts

Do's

1. Login-on with your username and password.
2. Log off the computer every time when you leave the Lab.
3. Arrange your chair properly when you are leaving the lab.
4. Put your bags in the designated area. 5. Ask permission to print.

DON'Ts

1. Do not share your username and password.
2. Do not remove or disconnect cables or hardware parts.
3. Do not personalize the computer setting.
4. Do not run programs that continue to execute after you log off.
5. Do not download or install any programs, games or music on computer in Lab.
6. Personal Internet use chat room for Instant Messaging (IM) and Sites is strictly prohibited.
7. No Internet gaming activities allowed.
8. Tea, Coffee, Water & Eatables are not allowed in the Computer Lab.

Course Outcomes:

The course outcomes of a Signals and Systems lab generally focus on developing practical skills in analysing, generating, and manipulating signals and systems using simulation tools like MATLAB or Simulink.

Upon successful completion of the lab, students should be able to:

- **Utilize Simulation Tools:** Demonstrate proficiency in using software such as MATLAB/Simulink for signal processing tasks, including basic programming, handling data, and using built-in functions.
- **Generate and Characterize Signals:** Generate various continuous-time and discrete-time signals (e.g., sinusoidal, step, impulse) and perform basic operations on them, such as time shifting, scaling, and inversion.

- **Analyse LTI Systems:** Analyse the properties and determine the response of Linear Time-Invariant (LTI) systems using concepts like convolution and impulse response.
- **Apply Transform Techniques:** Use Fourier series, Fourier transforms, Laplace transforms, and Z-transforms to analyse the spectral characteristics of signals and system responses in the frequency domain.

Course Layout of B. Des

SEMESTER V

Sl. No.	Course Code	Course Name	L	T	P	C
01.	UHS501	Industrial Management and Entrepreneurship	3	0	0	3
02.	UMD501	3D Animation	2	1	0	3
03.	UMD502	Audio Video Editing	2	0	0	2
04.	UMD503	Semiotics and Semantics in Design	2	0	0	2
05.	UMD571	3D Animation Lab	0	0	4	2
06.	UMD572	Audio Video Editing Lab	0	0	4	2
07.	UMD573	Semiotics and Semantics in Design Lab	0	0	4	2
08.	UMD591	Design Studio – V (3D Animation)	0	0	4	2
09.	UMD51*	Elective – II (Project based)	0	0	4	2
	Contact Hours: 30		**9**	1	**20**	**20**
Elective Subjects						
1.	UMD511	Instructional Design and Multimedia	0	0	4	2
2.	UMD512	Digital Sculpting	0	0	4	2
3.	UMD513	Advanced Texturing Techniques	0	0	4	2
4.	UMD514	Cultural Heritage Design	0	0	4	2
5.	UMD515*	Any other subject offered from time to time	0	0	4	2

Course Contents | Semester – 5

Course Title: Industrial Management and Entrepreneurship L-T-P-C: 3-0-0-3

Course Code: UHS501

Class Hours/week	Expected weeks	Total hours of classes
3	12	36
0	0	0

Course Objective/s:

The primary objectives of this course are to introduce students to the fundamental principles and functions of industrial management, to develop an understanding of organisational behaviour and human resource practices, and to cultivate knowledge of entrepreneurial concepts and the setup of small-scale industries necessary for managing design ventures or creative firms.

Learning Outcomes:

1. Explain and apply the core principles and functions of management (Planning, Organising, Coordinating, Controlling) and understand the role of a manager in a creative or industrial organisation.
2. Analyse human and group behaviour within organisational settings, specifically focusing on the influence of perception, attitude, motivation, and leadership styles on individual and team effectiveness and conflict resolution.
3. Describe and evaluate the key functions of Human Resource Management (HRM) in the Indian context, including the processes of recruitment, selection (job analysis, testing, interviewing), and the role of Trade Unions and Collective Bargaining.
4. Identify the meaning, types, and essential qualities of an entrepreneur, and analyse the factors that affect entrepreneurial growth, including the role of government schemes like the Engineer Entrepreneurship Training Programme.
5. Outline the steps and requirements for setting up a Small-Scale Industry (SSI), understand the operational problems, and identify the key sources of finance available from banks, government, and financial institutions for new ventures.

Unit	Topics	Content	Hours (T/P)
1	**Foundations of Management**	Meaning and Concept of Management, Principles and function of Management, Concept of Organizational Behaviour, Function of a Manager-Planning, Organizing, Coordinating and Controlling. Motivation-implications of Managers and Application.	6/0
2	**Leadership, Decision-Making, and Individual Organisational Dynamics**	Leadership and Decision Making: Qualities and Styles of Leadership, Decision-making Process. Individual Process in Organisations: Perception, Attitude and Personality, Factors that affect them, How they influence people.	6/0
3	**Group Dynamics and Organisational Effectiveness**	Group Process in Organisations: Group Formation, Group Effectiveness, and Group Conflict.	6/0

4	**Human Resource Management in India: Evolution and Staffing**	Evolution, Role and Status of Human Resource Management in India. Recruitment and Selection Process in Organisation, Job Analysis, Job Specification, Selection Process-Test and Interview.	6/0
5	**Entrepreneurship and Industrial Relations**	Trade Union and Collective Bargaining, Entrepreneurship - Meaning, Types of Entrepreneurs, Qualities of an Entrepreneur, Role of an Entrepreneur, Factors Affecting Entrepreneurial Growth. Entrepreneurship Development Programme - Concept, Objective and Importance, Engineer Entrepreneurship Training Programme Scheme.	6/0
6	**Small-Scale Industry, Corporate Structures, and Entrepreneurial Finance**	Small-Scale Industry-Definition, Types of Small-Scale Industry, How to Set up a Small-Scale Industry, Role and Problems of Small-Scale Industry. Concept of Joint Stock Company, Private and Public Limited Company. Source of Finance for Entrepreneur-Bank, Government and Financial Institutions, etc.	6/0

Textbooks / References:

1. S.S. Khanka - Organisational Behaviour, S. Chand Publishing, 4th Revised Edition, 2010.
2. S.S. Sarkar, R. K. Sharma and S. K. Gupta – Business Organisation and Entrepreneurship Development, Kalyani Publishers, 2014.
3. Cynthia L. Greene – Entrepreneurship: Ideas in Action, 6th Edition, South-Western Cengage Learning, 2017.

Course Title: 3D Animation L-T-P-C: 2-1-4-5

Course Code: UMD501/571

Class Hours/week	Expected weeks	Total hours of classes
3	12	36
4	12	48

Course Objective/s:

The primary objectives of this course are to establish a fundamental understanding of 3D animation principles and software workflows, to enable students to create convincing character and object motion based on real-world physics and acting principles, and to master the animation production pipeline from concept to final polish.

Learning Outcomes:

1. Execute foundational 3D animation techniques, including Key Frame Animation, Non-Linear Animation, and Path Animation, demonstrating a practical understanding of fundamental software controls and workflows.
2. Analyse and incorporate principles of physics and real-life motion studies (e.g., Path of Action, Line of Action) to create believable, weighty, and realistic movement for 3D characters and objects.
3. Systematically manage the 3D animation production process, from initial planning and creating thumbnails to blocking poses, setting proper timing, and iteratively refining the final motion.
4. Apply principles of drama and psychology to character animation, using concepts like the Laban movement theory and a detailed study of body language (posture, gesture) to convey emotion and character personality.
5. Design and implement basic facial expressions and lip synchronisation to effectively match character dialogue, completing the fundamental components of character performance in 3D animation.

Unit	Topics	Content	Hours (T/P)
1	**Animation Basics**	Introduction to 3D animation basics, Key Frame Animation, Animation Techniques: Non–Linear animation, Character Animation, Path Animation, Exercises and warm-ups.	6/12
2	**Motion Studies**	Motion Studies: Laws of Physics, Quick Studies from real life: Path of action, Line of action, Posing 3D characters.	6/12
3	**3D Animation Process**	The Animation Process: Planning, creating thumbnails, Blocking Poses, setting proper timing, refining the animation.	9/18
4	**Acting and Animation**	Drama and psychological effect- Laban movement theory, Study of Body language: posture, gesture.	9/18
5	**Lip Sync Basics**	Facial expression and lip sync.	6/12

Textbooks / References:

1. The Animator's Survival Kit - by Richard Williams; Faber Publications; Main - Revised edition (5 November 2009), ISBN-10: 9780571238347.

2. Mastering 3D Animation, by Peter Ratner; Allworth Press (September 1, 2000), ISBN-10: 1581150687.
3. Acting in Animation: A Look at 12 Films by Ed Hooks; Heinemann Drama (February 9, 2005), ISBN-10: 0325007055.
4. Digital Character Animation 3 - by George Maestri; New Riders Press (April 22, 2006), ISBN-10: 9780321376008.
5. Timing for Animation - by Harold Whitaker and John Halas; Focal Press; 2nd edition (September 3, 2009), ISBN-10: 9780240521602.

Course Title: Audio Video Editing L-T-P-C: 2-0-4-4

Course Code: UMD502/572

Course Objectives

1. To introduce the theoretical and aesthetic foundations of audio and video editing.
2. To understand the role of editing in visual storytelling and narrative structure.
3. To study various editing techniques and transitions used in film and digital media.
4. To provide knowledge of audio design, mixing, and synchronisation principles.
5. To understand the stages of the post-production workflow and industry practices.

Learning Outcomes

By the end of this course, students will be able to:

1. Explain the principles, functions, and aesthetics of audio-video editing.
2. Identify types of cuts, transitions, and editing styles in film and media.
3. Understand synchronisation of sound and image.
4. Analyse edited sequences in terms of rhythm, continuity, and narrative flow.
5. Describe the basic post-production workflow from raw footage to final output

Unit	Topics	Content	Hours (T/P)
1	**Fundamentals of Editing**	• Meaning and purpose of editing • Historical development of film editing • Editing as storytelling and construction of meaning • Key concepts: shot, sequence, scene, continuity, and montage • Roles of editor and post-production team	6/12
2	**Principles and Techniques of Video Editing**	• Continuity editing and the 180-degree rule • Match cuts, jump cuts, cross-cutting, and montage theory • Types of transitions: cut, dissolve, fade, wipe, etc. • Temporal and spatial relationships in editing	6/12
3	**Audio Editing and Sound Design**	• Types of sound: dialogue, ambient, effects, music • Diegetic and non-diegetic sound • Foley, dubbing, and ADR (Automated Dialogue Replacement) • Synchronization of audio with video • Sound mixing and balancing techniques	4/8
4	**Editing Workflow and Software Overview**	• Post-production stages: ingesting, organizing, and managing media • Timeline-based editing workflow • Basic tools and terminology of popular software: • Adobe Premiere Pro • DaVinci Resolve • Final Cut Pro • File formats, codecs, and exporting media	4/8

5	**Editing Styles and Case Studies**	• Classical Hollywood editing vs. experimental editing • Montage in Soviet cinema (Eisenstein, Pudovkin) • Modern digital editing aesthetics • Case study analysis: iconic edited scenes from Indian and World Cinema • Ethical and creative considerations in editing	4/8

Textbooks / References:

6. Talbot, Michael -Smith, Sound engineering explained, Focal Press, 2011.
7. Nisbett, Alec, The sound studio: audio techniques for radio, television, film and recording, Focal Press, 2003.
8. Mott, Robert L., Sound effects: radio, TV, and film, Focal Press, 1990.
9. Sonnenschein, David, Sound design: the expressive power of music, voice, and sound effects in cinema, Michael Wiese Productions, 2001.
10. Viers, Ric, The Sound Effects Bible: How to Create and Record Hollywood Style Sound Effects, Michael Wiese Productions, 2008.
11. Sergi, Gianluca, The Dolby era: film sound in contemporary Hollywood, Manchester University Press, 2004. Altman, Rick, Sound theory, sound practice, Routledge, 1992.
12. Alburger, James, The Art of Voice Acting, Focal Press, 2010, ISBN: 9780240812113.
13. Rumsey, Francis and TIM MCCORMICK, Sound and Recording, Focal Press, 2009, ISBN: 978024052163.

Course Title: Semiotics and Semantics in Design L-T-P-C: 2-0-0-2

Course Code: UMD503

Class Hours/week	Expected weeks	Total hours of classes
2	12	24
0	0	0

Course Objective:

To equip students with the analytical frameworks of semiotics and semantics (the study of signs and meaning) to interpret, deconstruct, and critically construct meaning across various design outputs. The course aims to develop a designer's ability to analyse how cultural contexts and design elements create, negotiate, and communicate messages within social and ideological contexts.

Learning Outcomes:

1. Analyse and differentiate the foundational semiotic models, specifically applying Saussure's dyadic model (signifier/signified) and Peirce's triadic model (Icon, Index, Symbol) to deconstruct design artefacts.
2. Apply the concepts of denotation and connotation to visual design elements, recognising the syntactic, semantic, and pragmatic dimensions of signs in communication.
3. Identify and interpret the role of visual and cultural codes in design, analysing how elements like colour, typography, and composition function as systems of meaning, and recognising underlying myths and ideologies (Barthes).
4. Evaluate product semantics, demonstrating an understanding of how form, material, and function communicate meaning, and critically analyse affordances and signifiers within UX/UI design.
5. Execute a systematic, step-by-step method for semiotic analysis on complex design artefacts (visual, product, or spatial), and articulate the difference between a designer's intent and user interpretation.
6. Critically discuss the social, cultural, and ethical implications of signs, reflecting on issues of representation, ideology, and the semiotics of place and space in contemporary design communication.

Unit	Topics	Content	Hours T/P
1	Introduction to Semiotics and Semantics	Origin and evolution of semiotics; sign, symbol, and meaning; Saussure's dyadic model (signifier and signified); relevance to design communication.	3/0
2	Theories and Models of Signs	Peirce's triadic model (icon, index, symbol); denotation and connotation; syntactic, semantic, and pragmatic dimensions; semiotic triangle; basic methods of semiotic analysis.	2/0
3	Codes, Conventions, and Visual Language	Visual and cultural codes; colour, typography, and composition as systems of meaning; myth and ideology (Barthes); reading and decoding images and interfaces.	2/0
4	Meaning in Product and Interaction Design	Product semantics: meaning through form, material, and function; affordances and signifiers in UX/UI design; cross-cultural interpretation of signs.	3/0
5	Metaphor and Narrative in Design	Conceptual metaphors (Lakoff); narrative and symbolic dimensions of design; role of storytelling in meaning formation; case examples from visual and	4/0

		spatial design.	
6	Culture, Context, and Ideology	Social and cultural context of meaning; representation, ethics, and ideology in design communication; semiotics of place, space, and signage.	3/0
7	Applied Semiotic Analysis	Frameworks for interpreting design artefacts; step-by-step method for semiotic analysis; reflective discussion on designer's intent vs. user interpretation.	5/0

Textbooks / References:

14. David Crow (2016). Visible Signs: An Introduction to Semiotics in the Visual Arts. Bloomsbury.
15. Ferdinand de Saussure (2011). Course in General Linguistics. Duckworth.
16. Charles Sanders Peirce (1955). Philosophical Writings of Peirce. Dover Publications.
17. Roland Barthes (1972). Mythologies. Hill and Wang.
18. Don Norman (2013). The Design of Everyday Things. Basic Books.
19. George Lakoff & Mark Johnson (1980). Metaphors We Live By. University of Chicago Press.
20. Juan A. Goguen (1999). "An Introduction to Algebraic Semiotics." Technical Report, UC San Diego.
21. Umberto Eco (1979). A Theory of Semiotics. Indiana University Press.
22. Gunther Kress & Theo van Leeuwen (2006). Reading Images: The Grammar of Visual Design. Routledge.
23. Winfried Nöth (1990). Handbook of Semiotics. Indiana University Press.

Course Title: Design Studio – V (3D Animation) L-T-P-C: 0-0-4-2

Course Code: UMD591

Class Hours/week	Expected weeks	Total hours of classes
0	0	0
4	12	48

Unit	Topics	Content
1	**Project 1**	**Project based on the following contents**: 3D Animation/Stillomatic: Line of action, Character blocking with poses, Story contents development and background design.
2	**Project 2**	**Group Project based on the following contents**: Animated short film on a select topic/story: Implementing the 12 principles of animation with an overview of the whole animation process, Character animation, Acting and lip-syncing & post-production.
4	**Project 3**	**Final design-based project report**.

Course Title: Instructional Design and Multimedia L-T-P-C: 0-0-4-2

Course Code: UMD511

Class Hours/week	Expected weeks	Total hours of classes
0	0	0
4	12	48

Course Objective/s:

The primary objectives of this course are to introduce students to the core principles of Instructional Design (ID), enabling them to apply theories of learning to the creation of effective multimedia and interactive interfaces. Students will learn to plan, architect, and prototype learning systems that facilitate optimal information transfer and user navigation.

Learning Outcomes:

1. Analyse and apply foundational instructional considerations to the design of interactive interfaces, justifying design choices based on case studies of effective multimedia and websites.
2. Conduct basic user studies and apply the principles of information architecture to identify information paths and hierarchies, ensuring effective navigation and content integration within a learning system.
3. Develop comprehensive design strategy documents for small learning Units and create detailed storyboards, effectively using metaphors to structure and communicate information design systems.
4. Design an interface tailored to specific domains of learning (e.g., cognitive, affective, psychomotor) and levels of learning (e.g., beginner, intermediate), demonstrating an understanding of learner-centric design.
5. Conceptualise, design, and prototype a functional multimedia product (e.g., an educational CD or a digital learning resource) that demonstrates a clear understanding of interactivity and meets a defined educational or social goal.

Unit	Topics	Content	Hours T/P
1	Foundations of Instructional Interface	Overview of interface and Instructional considerations in interactive design. Case studies, presentations of good websites and multimedia. Understanding the different domains and levels of learning for targeted interface development.	0/9
2	Information Architecture and User Study	Concepts of information architecture and user study (e.g., user personas). Identification of information paths and hierarchies. Strategies to integrate features and content for effective information navigation.	0/9
3	Design Strategy and Storyboarding	Storyboarding and mapping information hierarchies in information design systems. The effective use of metaphor in information design. Creating design strategy documents for small learning Units.	0/9
4	Multimedia Interactivity and Production	Understanding interactivity in multimedia. Development of a complete educational CD or multimedia piece for educational purposes or for a social cause, integrating all design and instructional principles.	0/9

Textbooks / References:

24. P. Mijksenaar and P. Wetendrop, *Open Here– The art of Instructional Design*, Thames and Hudson, 1999
25. J. Villamil and L. Molina, *Multimedia: production planning and delivery*, Prentice Hall, 1998
26. P. Mijksenaar, Visual Information–Introduction to Information Design, Princeton Architectural Press, 1998
27. M. Woolman, Type in motion, Innovation in Digital Information Graphics, Thames & Hudson, 2002

Course Title: Digital Sculpting L-T-P-C: 0-0-4-2

Course Code: UMD512

Class Hours/week	Expected weeks	Total hours of classes
0	0	0
4	12	48

Course Objective/s:

1. Understand the principles and workflows of digital sculpting.
2. Explore the relationship between traditional hand-drawn techniques and digital modeling.
3. Develop sculptural forms using industry-standard software.
4. Apply design techniques to enhance visual storytelling and character development.
5. Build a portfolio of sculpted models and creative experiments for career advancement.

Course Outcomes:

1. Demonstrate advanced technical proficiency in utilising industry-standard digital sculpting software (e.g., ZBrush, Blender) to create complex and high-resolution 3D forms.
2. Execute sculptural designs that reflect a deep understanding of form, anatomy, and gesture, effectively translating 2D conceptual sketches (hand-drawn practices) into detailed 3D models.
3. Apply various techniques for surface detailing and texture creation to enhance the realism and narrative quality of digital assets, moving beyond base geometry to defining final material appearance.
4. Independently conceptualise and produce diverse sculpted models, including fully detailed characters, creatures, and environment/prop assets, tailored for visual storytelling applications.
5. Prepare and present digital sculpts in a format suitable for professional workflows (e.g., animation, 3D printing, game engines), showcasing a portfolio that reflects creative experimentation and technical competency.

Unit	Topics	Contents	Hours T/P
1	Foundations and Tools	Introduction to digital sculpting tools and software (e.g., ZBrush, Blender). Understanding the principles and workflows of digital sculpting. Exploring the relationship between traditional hand-drawn techniques and digital modeling.	0/9
2	Form, Anatomy, and Design	Focus on the core principles of form, anatomy, and gesture in sculptural design. Translating hand-drawn sketches into initial 3D block-out models. Developing sculptural forms using industry-standard software.	0/9
3	Detailing and Texturing	Techniques for surface detailing and texture creation. Application of design techniques to enhance visual storytelling through sculpted details. Focus on character and creature sculpting.	0/9
4	Production and Workflow Integration	Focus on environmental and prop modeling. Integration of sculpted models with animation and game design pipelines. Building a portfolio of sculpted models and creative experiments for career advancement.	0/9

Textbooks / References:

28. Vaughan, William. Digital Modeling. New Riders, 2011.
29. Zarins, Uldis, and Sandis Kondrats. Anatomy for Sculptors: Understanding the Human Figure. Anatomy Next, 2019.
30. Faraut, Philippe, and Charisse Faraut. Mastering portraiture: advanced analyses of the face sculpted in clay. PCF Studios, 2009.

Course Title: Advanced Texturing Techniques L-T-P-C: 0-0-4-2

Course Code: UMD513

Class Hours/week	Expected weeks	Total hours of classes
0	0	0
4	12	48

Course Objective:

The course "Advanced Texturing Techniques" is designed to equip students with the professional skills required to create high-quality textures and materials for animation, VFX, CGI films, and game production. The course focuses on mastering UV mapping, understanding physically based rendering (PBR) principles, and developing a complete range of texture maps such as base color, roughness, metallic, normal, height, and displacement. Students learn to work with both procedural and hand-painted workflows using industry-standard tools, enabling them to build accurate, realistic, and production-ready surfaces. By integrating their textures into modern rendering and shading pipelines, students gain practical experience in look development, preparing them for the technical demands and creative challenges of contemporary CGI and game studios.

Course Outcome:

1. Apply professional UV mapping techniques to create clean, distortion-free, and optimized UV layouts suitable for high-resolution texturing and efficient production workflows.
2. Develop complete physically based (PBR) texture sets—including base colour, roughness, metallic, height, normal, and displacement maps—using industry-standard tools and pipelines.
3. Implement PBR workflows to accurately represent surface properties, achieving realistic material response under various lighting conditions used in CGI, gaming, and animation.
4. Create production-ready materials with correct colour visualization, micro-detail accuracy, and optimized map resolutions that meet the standards of animation, VFX, and real-time game engines.
5. Integrate all texture maps into rendering and shading pipelines to achieve cohesive, consistent, and visually polished look-development outputs for final production.

Unit	Topics	Contents	Hours T/P
1	Introduction to Advanced Texturing and Surface Basics	Texturing in CGI uses PBR workflows and texture maps to define surface properties and create realistic materials for animation, films, ads, and games.	4/4
2	UV Mapping and Texture Baking	Develop a clear understanding of UV mapping and professional unwrapping techniques to create clean, efficient layouts. Generate and refine essential baked maps using industry-standard workflows to ensure accurate surface detail and readiness for advanced texturing.	4/8
3	Foundation of PBR Texture Map Creation	Create lighting-free Base Color textures, generate Roughness and Metallic maps for realistic reflectivity, add micro-details through Normal and Height maps, apply Displacement for true depth, and optimize textures for efficient use in CGI and real-time engines.	4/12
4	Advanced Material Development and Procedural Texturing	Apply procedural and hand-painted texturing effectively, using generators, noise, and masks to create detailed materials. Build layered, realistic surfaces with accurate properties and ensure consistency under varied lighting.	4/8
5	Surface Aging,	Create realistic wear effects with micro-details, using	4/8

	Weathering, and Texture Detailing	layered textures to support storytelling and produce naturally aged surfaces.	
6	Surface Aging, Weathering, and Texture Detailing	Integrate texture maps into rendering pipelines, manage shader networks for consistent look development, apply proper color management, and optimize resolutions and UDIMs for efficient, production-ready assets.	4/8

Textbooks / References:

31. Kelly L. Murdock — Autodesk Maya 2024 Basics Guide. SDC Publications, July 2023. ISBN: 978-1-63057-580-9.
32. CADCIM Technologies / Prof. Sham Tickoo — Autodesk Maya 2024: A Comprehensive Guide (15th Edition). 2023–24. ISBN: 978-1-64057-185-3.
33. Frédéric Durand — Cinematic CG Lighting and Rendering: CG Enlightenment with Maya, Nuke, Arnold and V-Ray. Bloomsbury Academic, 2022. ISBN: 978-1-35002-543-1.
34. Zhou Jing Lai — Maya Arnold Material Lighting Rendering Technology from Entry to Actual Combat (Micro-Course Video Version) (Chinese Edition). Tsinghua University Press, February 2024. ISBN: 978-7-3026-5379-0.
35. Lee Lanier — Advanced Maya Texturing and Lighting, Third Edition. Autodesk Maya Press, Wiley Publishing Inc., 2015.

Course Title: Cultural Heritage Design L-T-P-C: 0-0-4-2

Course Code: UMD514

Class Hours/week	Expected weeks	Total hours of classes
0	0	0
4	12	48

Course Objective:

The course "Cultural Heritage Design" aims to develop students' ability to translate cultural identity, traditional aesthetics, and archival knowledge into innovative design outcomes. Through hands-on exploration of cultural motifs, artifacts, symbols, and visual narratives, students learn how to preserve and reinterpret heritage through contemporary design practices. The course emphasizes cultural preservation, responsible representation, and the creative transformation of historical and community-based resources into novel visual solutions. By engaging directly with archival material, cultural references, and design experimentation, learners build the skills needed to generate original, culturally grounded design work suitable for modern creative industries.

Course Outcome:

1. Understand and analyze cultural traditions, symbols, artefacts, and narratives, and apply them thoughtfully within contemporary design contexts.
2. Interpret cultural aesthetics and visual languages to create designs that are authentic, respectful, and aligned with community identity and heritage.
3. Develop design concepts informed by historical research, transforming cultural stories and practices into modern visual outcomes.
4. Create culturally inspired artworks, graphics, or design prototypes that balance heritage preservation with modern creative expression.
5. Apply ethical, responsible, and context-aware design practices when working with cultural materials, ensuring sensitivity and accuracy in representation.
6. Present design solutions that effectively communicate cultural meaning, supporting the awareness, preservation, and appreciation of cultural heritage in contemporary society.

Unit	Topics	Content	Hours T/P
1	Introduction to Cultural Heritage Design	Overview of cultural identity, traditional aesthetics, and symbolic visual language. Understanding how cultural motifs and narratives inform contemporary 2D/3D design practices.	4/4
2	Cultural Research, Archiving, and Visual Documentation	Exploration of archival sources, artefacts, and cultural references. Techniques for documenting heritage elements through observational sketches, digital scan, photographic reference, and structured visual recording methods.	4/8
3	Interpreting Cultural Motifs and Visual Languages	Analysis of patterns, symbols, ornaments, textiles, and architectural elements. Translating cultural forms into modern design concepts.	4/12
4	Heritage-Based Creative Development in 2D and 3D	Creating contemporary visual outcomes inspired by cultural stories and traditions. Applying both 2D and 3D software tools to reinterpret cultural elements into innovative digital artworks and design prototypes.	4/8
5	Cultural Preservation	Applying ethical, accurate, and culturally sensitive	4/8

	and Responsible Design Practices	approaches to heritage-based design. Ensuring respectful representation while maintaining authenticity and cultural integrity.	
6	Final Cultural Design Integration and Digital Presentation	Producing complete cultural design solutions using combined 2D and 3D workflows. Presenting projects that communicate cultural meaning and support awareness, preservation, and appreciation of heritage.	4/8

Textbooks / References:

36. Cristina Cantagallo, Valentino Sangiorgio, Humberto Varum, Francesco Fiorito & Fabio Fatiguso — Digitization of Built Heritage: Approaches and Methods for Data Acquisition, Analysis, and Intervention. Springer, 2025. ISBN: 978-3-031-96598-2.
37. Jayanta Mukhopadhyay, Indu Sreedevi, Bhabatosh Chanda, Santanu Chaudhury & Vinay P. Namboodiri — Digital Techniques for Heritage Presentation and Preservation. Springer, 2021. ISBN: 978-3-030-57907-4.
38. Mohamed Marzouk (Ed.) — Heritage Building Conservation: Sustainable and Digital Modelling. Routledge, 2023 (1st Edition). eBook ISBN: 978-1-003-35748-3.

Department of Humanities and Social Sciences

Name of the Programme:	B. Tech
Semester:	Fifth

Course Code:	UHS501
Course Title:	Industrial Management and Entrepreneurship
Course Credit:	3 (L: 3 T:0 P: 0)
Course objective:	The primary objective of this course is to provide engineering students with a broad understanding of management and entrepreneurial principles, equipping them to excel in managerial roles or to start and manage their own ventures. The Course Objectives for Industrial Management and Entrepreneurship are: 1. To gain knowledge of core management concepts, principles, and practices. 2. To develop skills in managing operations, including production planning, scheduling, and quality control. 3. To formulate and implement strategies for achieving organizational goals. 4. To understand the role of motivation, communication, and conflict resolution in managing teams. 5. To study different types of entrepreneurship, including social and corporate entrepreneurship. 6. To learn techniques for identifying and developing innovative business ideas. 7. To explore methods for market research and validation of business concepts.
Pre-requisites:	Codes of the courses which may be listed as pre-requisites for this course (preferably from the earlier semester's curricula of the programme).
Course outcomes:*	After Completion of this course students will **1.Apply Management Theories:** Demonstrate the ability to apply core management theories and principles to industrial scenarios, effectively addressing organizational

	and operational challenges. **2.Manage Resources Effectively:** Develop strategies for the optimal management and allocation of resources, including human, material, and financial resources, to achieve organizational goals **3.Develop Viable Business Ideas:** Generate and evaluate innovative business ideas, using market research and feasibility analysis to validate potential opportunities. **4.Implement Effective Marketing Strategies:** Design and execute marketing and sales strategies to build brand awareness, attract customers and achieve market positioning. **5.Manage Start-up Operations:** Demonstrate the ability to manage the day-to-day operations of a start-up, including handling team dynamics, scaling operations and managing growth effectively.

Unit/ Module no.	Topic	Nos. of contact hours	Distribution of marks (out of 100)
1	Meaning and Concept of Management, Principles and function of Management, Concept and scope of Organizational Behavior, Function of a Manager—Planning, Organizing, Coordinating and Controlling, Motivation—implication of Managers and application. Leadership, Qualities and Styles of Leadership, Decision making process.	8	20
2	Individual Process in Organizations-Personality, Perception, and Attitude, Factors that affect them, How they influence people. Organizational Conflicts and Conflict Management, SWOT Analysis: Meaning and Significance, Job Satisfaction and Job Dis-Satisfaction: Meaning and Effect, Concept of Stress Management and Time Management	10	25
3	Evolution, Role and Status of Human Resource Management in India. Recruitment and Selection Process in Organization- Job Analysis-Job Specification-Selection Process-	8	15

	Test and Interview. Trade Union and Collective Burgaining.		
4	Entrepreneurship-Meaning, Types of entrepreneur, Qualities of an entrepreneur, Role of Entrepreneur, Factors affecting entrepreneurial growth. Entrepreneurship Development Programme-Concept, Objective and Importance, Modern Marketing Tools for Entrepreneurs, Business Idea: Meaning and Factors affecting generation of Business Idea, Concept of Creativity and Innovation for Startups. Business Opportunity Analysis.	8	25
5	Small Scale Industry-Definition, Types of Small-Scale Industry, How to Set up Small Scale Industry, Role and Problem of Small-Scale Industry, Concept of Joint Stock Company, Private and Public Limited Company, Meaning of IPR, Legal and Ethical Issues of the Entrepreneur	8	15

Text Books:

1. khanka, S.S (2023) , New-Delhi, OrganisationalBehaviour , S.Chand& Company

2.Sarkar, S.S. , Sharma, R.K.andGupta, S.K. (2021), New-Delhi, Business Organisation and Entrepreneurship Development ,Kalyani Publishers

3.Debnath, Arabinda (2015), Guwahati, Principles of Management ,BLG Publication

4.. Prasad, L.M. (2020), New-Delhi, Principles and Practice of Management , S.Chand& Company

5. Khanka, S.S.(2020), New Delhi, Entrepreneurial Development , S.Chand& Company

6.Debnath, Arabinda (2018), New Delhi, Industrial Management and Entrepreneurship, Kalyani Publishers

Reference Books:

1..Shukla, M.B. (2015), Guwahati, Entrepreneurship and Small Business Management, KitabMahal

2. Bhatia, Kanchan and Mittal, Shweta(2016),New-Delhi, Management Concept and Practice ,Variety Books Publishers & Distributors

** In the context of accreditation, a course outcome (CO) is a specific, measurable statement that describes what students should know, understand, and be able to do after completing a course. The maximum number of outcomes for a course is expected to be around 6 as per NBA document. COs should reflect on the measurable outcomes towards attaining the outcomes of the Programme.*