

Thapar  
Institute of  
Engineering  
&  
Technology

# PO's & CLO's of all Engineering Programs

## **2.6.1**

# **The Sequence of proofs is as follows:**

- I. Mechanical Engineering Department
- II. Biotechnology Department
- III. Civil Engineering Department
- IV. Computer Science & Engineering Department
- V. Electronics & Communication Engineering Department
- VI. Electrical & Instrumentation Engineering Department
- VII. Chemical Engineering Department
- VIII. School of Chemistry and Biochemistry
- IX. School of Energy & Environment
- X. School of Humanities & Social Science
- XI. School of Mathematics
- XII. LMT School of Management
- XIII. School of Physics & Material Science

## **BE Mechanical Engineering**

<b>Program Educational Objectives (PEO) Description</b>	
The undergraduate program in Mechanical Engineering at Thapar Institute of Engineering and Technology is designed to prepare its graduates for continued learning and successful careers in industry, government, academia and consulting. Our graduates are expected to :	
<b>PEO1</b>	Apply engineering knowledge, critical thinking and problem solving skills in professional engineering practice or in non-engineering fields or business.
<b>PEO2</b>	Continue their intellectual development imbuing ability for lifelong learning by pursuing higher education or professional development courses.
<b>PEO3</b>	Embrace leadership roles in their careers.
<b>PEO4</b>	Innovate continuously for societal improvement.
<b>Program Outcomes (POs) Description</b>	
The students of Bachelor's Program in Mechanical Engineering will be able to :	
<b>PO1</b>	<b>Engineering knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
<b>PO2</b>	<b>Problem analysis:</b> Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
<b>PO3</b>	<b>Design/development of solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
<b>PO4</b>	<b>Conduct investigations of complex problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
<b>PO5</b>	<b>Modern tool usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
<b>PO6</b>	<b>The engineer and society:</b> Apply reasoning informed by the contextual knowledge to

	assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
<b>PO7</b>	<b>Environment and sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
<b>PO8</b>	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
<b>PO9</b>	<b>Individual and team work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
<b>PO10</b>	<b>Communication:</b> Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
<b>PO11</b>	<b>Project management and finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
<b>PO12</b>	<b>Life-long learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## **BE Mechatronics Engineering**

<b>Program Educational Objectives (PEO) Description</b>	
The undergraduate program in Mechatronics Engineering at Thapar Institute of Engineering and Technology is designed to prepare its graduates for continued learning and successful careers in industry, government, academia and consulting. Our graduates are expected to :	
<b>PEO1</b>	Apply engineering knowledge, critical thinking and problem solving skills in professional engineering practice or in non-engineering fields or business.

<b>PEO2</b>	Continue their intellectual development imbining ability for lifelong learning by pursuing higher education or professional development courses.
<b>PEO3</b>	Embrace leadership roles in their careers.
<b>PEO4</b>	Innovate continuously for societal improvement.
<b>Program Outcomes (POs) Description</b>	
The students of Bachelor's Program in Mechatronics Engineering will be able to :	
<b>PO1</b>	<b>Engineering knowledge:</b> Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
<b>PO2</b>	<b>Problem analysis:</b> Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
<b>PO3</b>	<b>Design/development of solutions:</b> Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
<b>PO4</b>	<b>Conduct investigations of complex problems:</b> Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
<b>PO5</b>	<b>Modern tool usage:</b> Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
<b>PO6</b>	<b>The engineer and society:</b> Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
<b>PO7</b>	<b>Environment and sustainability:</b> Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
<b>PO8</b>	<b>Ethics:</b> Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
<b>PO9</b>	<b>Individual and team work:</b> Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
<b>PO10</b>	<b>Communication:</b> Communicate effectively on complex engineering activities with

	the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
<b>PO11</b>	<b>Project management and finance:</b> Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
<b>PO12</b>	<b>Life-long learning:</b> Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
<b>Program Specific Outcomes (PSOs) Description</b>	
The students of Bachelor's Program in Mechatronics Engineering will be able to:	
<b>PSO1</b>	<b>Core competency:</b> Design, compose, evaluate, review, report, direct, and supervise the application of electro-mechanical principles to meet the needs of the society to safeguard life, health, property and societal welfare.
<b>PSO2</b>	<b>Practical competency:</b> Ability to implement and integrate electronic, mechanical, electromechanical, control and computer systems that contain software and hardware components, including sensors, actuators and controllers.

# M.E. – PRODUCTION ENGINEERING

## Program Educational Objectives and Program Outcomes

### M.E. (Production Engineering) Program

<b>ME Production Engineering</b>	
<b>Program Educational Objectives (PEO) Description</b>	
The Master’s program in Production Engineering at Thapar Institute of Engineering and Technology is designed to prepare its graduates in specialized areas of industrial and production engineering systems for successful career in industry, academia and research. Our graduates are expected to :	
<b>PEO1</b>	Independently create and synthesize knowledge, present technical reports, imbibing professional and ethical practices.
<b>PEO2</b>	Employ modern engineering tools and critical thinking in solving professional engineering problems and develop solutions through innovation and creativity for societal improvement.
<b>PEO3</b>	Exhibit effective project management skills in contemporary organizational context and continue their intellectual development through lifelong learning.
<b>Program Outcomes (POs) Description</b>	
The students of Master’s Program in Production Engineering will have :	
<b>PO1</b>	Ability to independently carry out research /investigation and development work to solve practical problems
<b>PO2</b>	Ability to write and present a substantial technical report/document
<b>PO3</b>	Ability to demonstrate a degree of mastery over the area as per the specialization of the program at a level higher than the requirements in the appropriate bachelor program.
<b>PO4</b>	Ability to recognize a need for, and engage in life-long learning.



<b>PO5</b>	Ability to plan and execute projects effectively. (To be mapped with seminar/ minor project)
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## ME-CAD/CAM Engineering

<b>ME CAD/CAM Engineering</b>	
<b>Program Educational Objectives (PEO) Description</b>	
The Master's program in CAD/CAM Engineering at Thapar Institute of Engineering and Technology is designed to prepare its graduates in specialized areas of Computer Aided Design and Manufacturing for successful career in industry, academia and research. Our graduates are expected to :	
<b>PEO1</b>	Independently create and synthesize knowledge, present technical reports, imbibing professional and ethical practices.
<b>PEO2</b>	Employ modern engineering tools and critical thinking in solving professional engineering problems and develop solutions through innovation and creativity for societal improvement.
<b>PEO3</b>	Exhibit effective project management skills in contemporary organizational context and continue their intellectual development through lifelong learning.
<b>Program Outcomes (POs) Description</b>	
The students of Master's Program in CAD/CAM Engineering will have :	
<b>PO1</b>	Ability to independently carry out research /investigation and development work to solve practical problems
<b>PO2</b>	Ability to write and present a substantial technical report/document
<b>PO3</b>	Ability to demonstrate a degree of mastery over the area as per the specialization of the program at a level higher than the requirements in the appropriate bachelor program.
<b>PO4</b>	Ability to recognize a need for, and engage in life-long learning.
<b>PO5</b>	Ability to plan and execute projects effectively.

# Course Learning Outcomes

CLO No	CLO	SUBJECT CODE	SUBJECT NAME
1	Select and analyze a set of mechanisms to achieve desired motion transformation.	UME306	MECHANICS OF MACHINES
2	Use analytical methods and software tools for analysis of mechanisms.	UME306	MECHANICS OF MACHINES
3	Evaluate and carry out balancing of rotors.	UME306	MECHANICS OF MACHINES
4	Determine the unbalance and evaluate the balancing strategies in multi cylinder in-line engines.	UME306	MECHANICS OF MACHINES
5	Formulate equations of motion, evaluate the responses of different real life vibration problems and suggest methods for vibration isolation.	UME306	MECHANICS OF MACHINES
1	Analyse lacunae in existing layout of a shop floor in manufacturing and service organizations and develop an improved layout	UME515	INDUSTRIAL ENGINEERING
2	Apply quality engineering tools for process control and improvement	UME515	INDUSTRIAL ENGINEERING
3	Develop a production schedule using information/data from different functional areas	UME515	INDUSTRIAL ENGINEERING
4	Determine the optimum time standards using work study principles and human factors engineering	UME515	INDUSTRIAL ENGINEERING
1	Analyse simple Brayton cycle and determine the performance parameters of jet engine	UME501	APPLIED THERMODYNAMICS
2	Draw heat balance sheet of a boiler	UME501	APPLIED THERMODYNAMICS
3	Determine the performance parameters of IC engine test rig	UME501	APPLIED THERMODYNAMICS
4	Derive and analyze Otto, Diesel and dual cycle air standard thermal efficiencies	UME501	APPLIED THERMODYNAMICS
1	calculate the state of stress at the critical point of the object.	UME404	MECHANICS OF DEFORMABLE BODIES
2	analyze the failure analysis under static loading in ductile and brittle materials using different theories of failures.	UME404	MECHANICS OF DEFORMABLE BODIES
3	calculate deflection at any point on a solid structure using Castigliano's theorems.	UME404	MECHANICS OF DEFORMABLE BODIES
4	determine the distribution of circumferential and radial stress along the thickness of thick cylinders.	UME404	MECHANICS OF DEFORMABLE BODIES
5	model real structures using fundamental component analysis.	UME404	MECHANICS OF DEFORMABLE BODIES
6	use contemporary s/w tools of MATLAB and FEA commercial packages for solving and displaying results.	UME404	MECHANICS OF DEFORMABLE BODIES
1	Decide suitable casting technique for a particular application based on the differentiation in process salient features, evaluate the molding sand property for sand casting process.	UME505	MANUFACTURING TECHNOLOGY

2	Design the gating and riser system for the casting process and calculate the charge constituents in liquid metal	UME505	MANUFACTURING TECHNOLOGY
3	Determine the welding machine characteristics, calculate heat balance, estimate the size of weld and decide suitable welding technique for different applications.	UME505	MANUFACTURING TECHNOLOGY
4	Calculate the shear angle, strain, strain rate, velocities during metal cutting and estimate the cutting force, power during single and multipoint cutting operations.	UME505	MANUFACTURING TECHNOLOGY
5	calculate the force and power requirements during different bulk metal forming processes estimate the die or punch size for a suitable sheet metal shearing operation.	UME505	MANUFACTURING TECHNOLOGY
1	apply engineering principle of mechanics to design motion transmission devices and flywheels.	UME513	DYNAMICS & VIBRATIONS
2	determine the appropriate parameters for stability of a vehicle using the concept of gyroscopic action.	UME513	DYNAMICS & VIBRATIONS
3	derive the dynamic model of real-life problems and verify the natural frequencies and mode shapes.	UME513	DYNAMICS & VIBRATIONS
4	Analyze two- and multi-DOF physical systems analytically and validate using a commercial package	UME513	DYNAMICS & VIBRATIONS
1	Develop a case for productivity improvement in any manufacturing or service industry scenario	UPE501	WORK STUDY AND ERGONOMICS ENGINEERING
2	Independently conduct a method study in any organization with the objective of improving a process, material movement system or design of a work place	UPE501	WORK STUDY AND ERGONOMICS ENGINEERING
3	Develop time standards for operations, identify production bottlenecks and improvise operations	UPE501	WORK STUDY AND ERGONOMICS ENGINEERING
4	Apply principles of good ergonomic design of work areas and equipment	UPE501	WORK STUDY AND ERGONOMICS ENGINEERING
5	Identify, explain and evaluate the impact of various personal attributes (anatomical, physiological and anthropometric) on proper safe working practice	UPE501	WORK STUDY AND ERGONOMICS ENGINEERING
1	describe the microstructures and phases that will occur in material alloys in general, and steels and eutectic series alloys in particular.	UME733	INDUSTRIAL METALLURGY
2	predict how microstructure will be affected by alloy composition and thermomechanical treatments.	UME733	INDUSTRIAL METALLURGY
3	describe the structure and processing of some typical steels; to compare the mechanical properties of these materials to those of composites explaining under what circumstances composites might be used in the industry.	UME733	INDUSTRIAL METALLURGY
4	select and analyse suitable surface heat treatment for a given alloy composition.	UME733	INDUSTRIAL METALLURGY
5	predict the failure loads in components to ensure their safe life.	UME733	INDUSTRIAL METALLURGY

6	appreciate the considerations involved in mechanical engineering materials selection: to use a systematic approach to the selection of the optimum material for a given mechanical engineering application.	UME733	INDUSTRIAL METALLURGY
1	identify and analyze the functions and organization of industrial inspection.	UME407	INSPECTION AND QUALITY CONTROL
2	apply and analyze the seven Ishikawa's tools and conduct quality cost analysis.	UME407	INSPECTION AND QUALITY CONTROL
3	analyze various control charts for quality control of the different production processes	UME407	INSPECTION AND QUALITY CONTROL
4	evaluate through process capability studies if a given process is proficient in meeting customer's specifications	UME407	INSPECTION AND QUALITY CONTROL
5	apply the basic concepts involved in the working of instruments for line and angle measurements.	UME407	INSPECTION AND QUALITY CONTROL
1	Analyze the design philosophy and design process adopted for the development of machine tools.	UME844	MACHINE TOOL DESIGN
2	Analyze the constructions and structural behavior of a machine tool.	UME844	MACHINE TOOL DESIGN
3	Analyze the drive and control systems used in machine tools	UME844	MACHINE TOOL DESIGN
4	Design the components and subsystems of a given machine.	UME844	MACHINE TOOL DESIGN
1	Develop dimensionless groups using Buckingham's Pi method	UME713	Fluid Mechanics & Machinery
2	Determine the drag and lift forces of various shapes	UME713	Fluid Mechanics & Machinery
3	Determine the various flow characteristics of pumps and turbine	UME713	Fluid Mechanics & Machinery
4	Simulate fluid machinery problems using commercial CFD tools	UME713	Fluid Mechanics & Machinery
1	radiation mode of heat transfer to solve heat transfer problems.	UME712	HEAT TRANSFER
2	design a heat exchanger through analysis of the thermal performance of heat exchangers and recognize and evaluate the conflicting requirements of heat transfer optimization and pressure drop minimization.	UME712	HEAT TRANSFER
3	calibrate equipment, acquire, tabulate and analyze useful data in the laboratory, checks for repeatability and reproducibility.	UME712	HEAT TRANSFER
4	assess thermal systems and develop conceptual designs of improved systems	UME712	HEAT TRANSFER
1	Calculate cutting forces and power requirement during single point and multi point cutting operations	UME705	MACHINING SCIENCE
2	Develop mathematical models to predict material removal rate and surface quality for different non traditional machining methods	UME705	MACHINING SCIENCE

3	Evaluate the various sources of heat load on buildings and perform a heat load estimate	PTH202	REFRIGERATION AND AIR CONDITIONING SYSTEM DESIGN
4	Design summer and winter air conditioning systems.	PTH202	REFRIGERATION AND AIR CONDITIONING SYSTEM DESIGN
5	Design ducts for central air condition systems.	PTH202	REFRIGERATION AND AIR CONDITIONING SYSTEM DESIGN
1	Develop dimensionless groups using buckingham's Pi method	PTH324	HYDRODYNAMIC MACHINES
2	Determine the drag and lift forces of various shapes	PTH324	HYDRODYNAMIC MACHINES
3	Determine the various flow characteristics of pumps and turbine	PTH324	HYDRODYNAMIC MACHINES
4	Design the fluid machinery system	PTH324	HYDRODYNAMIC MACHINES
1	conduct a failure analysis for the design/sizing of mechanical components	UME408	MACHINE DESIGN-I
2	calculate stresses involved with static/ fatigue loading	UME408	MACHINE DESIGN-I
3	design and analyze a real engineering system through projects	UME408	MACHINE DESIGN-I
4	represent machine elements with a free body diagram and solve for unknown reactions.	UME408	MACHINE DESIGN-I
5	select the suitable materials and manufacturing considerations.	UME408	MACHINE DESIGN-I
2	Perform thermodynamic analysis of absorption refrigeration systems and steam jet refrigeration system.	PTH202	REFRIGERATION AND AIR CONDITIONING SYSTEM DESIGN
3	Design the conditions for the maximum tool life and factors influencing dimensional accuracy in machining	UME705	MACHINING SCIENCE
4	analyse the thermal and frictional aspects of machining parameters used in manufacturing industries	UME705	MACHINING SCIENCE
1	Select the suitable materials and manufacturing considerations.	UME711	MACHINE DESIGN -II
2	Determine suitable module and specifications of gears from strength and wear considerations.	UME711	MACHINE DESIGN -II
3	Apply different theories for designing friction clutches and brakes.	UME711	MACHINE DESIGN -II
4	Select bearings for a given load carrying capacity.	UME711	MACHINE DESIGN -II
5	Design and analyze real engineering systems through research assignments.	UME711	MACHINE DESIGN -II
1	Evaluate the power requirement of a vehicle under different operating conditions.	UME502	AUTOMOBILE ENGINEERING
2	Calculate the energy losses and define the design parameters in different vehicle components.	UME502	AUTOMOBILE ENGINEERING

3	Solve the technical issues related to vehicle design and malfunctioning of different components through fault-diagnosis and troubleshooting exercises of real case studies performed at the vehicle service stations.	UME502	AUTOMOBILE ENGINEERING
1	create plan for automatic machining of a given part on a multi-axis CNC machining center including selection of machining parameters, cutting tools, process sequence and controller settings for tool presets.	UPE704	COMPUTER AIDED MANUFACTURING
2	create and validate a CNC part program data using manual data input (MDI) for automatic machining of a given parts/surface using a 2-axis turning center or 3-axis vertical milling center.	UPE704	COMPUTER AIDED MANUFACTURING
3	create and validate a CNC part program data using a commercial CAM package for automatic machining of precision parts or part surface for a multi-axis CNC machining centre.	UPE704	COMPUTER AIDED MANUFACTURING
4	produce an industrial component from given 3D part model/ 2D part drawings using CNC machining centers through programming, setup, and ensuring safe operation of automatic machine tools.	UPE704	COMPUTER AIDED MANUFACTURING
1	analyze the thermal aspects during solidification in casting and their role on quality of cast	UPE702	METAL CASTING AND JOINING
2	design the gating and riser system needed for casting and requirements to achieve defect free casting.	UPE702	METAL CASTING AND JOINING
3	analyze the welding process behavior of common and newer welding techniques	UPE702	METAL CASTING AND JOINING
4	analyze the requirements to achieve a sound welded joint of engineering materials.	UPE702	METAL CASTING AND JOINING
1	Deciding yielding of a material according to different yield theory for a given state of stress	UPE703	METAL FORMING
2	Analyze the different bulk metal forming process mechanics using different analyze approach and calculate the force, power requirements etc.	UPE703	METAL FORMING
3	Calculate the die and punch sizes for different sheet metal operations and to calculate the required load for the process	UPE703	METAL FORMING
4	Evaluate the effect of process parameters on the process mechanics during bulk metal forming.	UPE703	METAL FORMING
1	apply the procedure involved to solve a problem using finite element methods	UME832	FINITE ELEMENT METHODS
2	develop the element stiffness matrices using different approach.	UME832	FINITE ELEMENT METHODS
3	Analyze a 2D and 3D problem using different types of elements.	UME832	FINITE ELEMENT METHODS
4	solve problems using the available commercial package.	UME832	FINITE ELEMENT METHODS
1	Frame bond graphs of systems using power variables, reference power directions, causality.	UME722	SYSTEM MODELLING AND SIMULATION

2	Generate the system equations from bond graph models.	UME722	SYSTEM MODELLING AND SIMULATION
3	Make signal flow graph from the bond graph model and predict stability using Routh's criterion	UME722	SYSTEM MODELLING AND SIMULATION
4	Create different control systems using bond graph.	UME722	SYSTEM MODELLING AND SIMULATION
1	Identify and formulate the desired robotic design specification for a particular application	UME805	ROBOTICS ENGINEERING
2	Develop and Simulate the forward kinematics model using D-H conventions	UME805	ROBOTICS ENGINEERING
3	Develop the inverse kinematics model of a serial manipulator	UME805	ROBOTICS ENGINEERING
4	Develop and analyze the mathematical model for robotics trajectory planning, resolved motion rate control and dynamics for a given serial robotic manipulator.	UME805	ROBOTICS ENGINEERING
5	Apply the joint and cartesian based schemes to control the manipulators in different applications.	UME805	ROBOTICS ENGINEERING
1	determine the properties of fiber and matrix of composite material in different orientations.	UME842	MECHANICS OF COMPOSITE MATERIALS
2	predict the elastic properties of both long and short fiber composites.	UME842	MECHANICS OF COMPOSITE MATERIALS
3	relate stress, strain and stiffness tensors using ideas from matrix algebra	UME842	MECHANICS OF COMPOSITE MATERIALS
4	analyze a laminated plate in bending, including finding laminate properties from lamina properties.	UME842	MECHANICS OF COMPOSITE MATERIALS
5	determine the failure strength of a laminated composite plate	UME842	MECHANICS OF COMPOSITE MATERIALS
1	Apply the underlying fundamentals of automation strategies, industrial automation and CNC technology	UME732	CAM & INDUSTRIAL AUTOMATION
2	Develop a complete machining plan for precision parts using an appropriate CNC machining centers	UME732	CAM & INDUSTRIAL AUTOMATION
3	Design and simulate an automation system for manufacturing automation based on pneumatic, hydraulic or electro-hydraulic control using logic circuits and control elements	UME732	CAM & INDUSTRIAL AUTOMATION
4	Design and develop a complete automation solution using i.e. Flexible Manufacturing system (FMS) for a need	UME732	CAM & INDUSTRIAL AUTOMATION
1	identify different causes of wears and friction in different contact surfaces.	UME721	TRIBOLOGY
2	calculate load carrying capacity of hydrostatic bearings.	UME721	TRIBOLOGY
3	analyze real life problem in Tribology.	UME721	TRIBOLOGY
1	construct the block diagram of any physical mechatronics device used in day-to-day life.	PCD103	Mechatronics
2	calculate the output to input relation of any physical model in the form of a transfer function.	PCD103	Mechatronics
3	evaluate the performance of any physical system in terms of its performance parameters.	PCD103	Mechatronics



4	develop the mathematical model of any physical model from any engineering domain.	PCD103	Mechatronics
5	interface the sensors and actuators of a mechatronic device to the computer/laptop.	PCD103	Mechatronics
6	recognize the key features of different type of controllers and develop a suitable controller to obtain the desired performance from the system.	PCD103	Mechatronics
1	apply the concepts of machining for the purpose of selection of appropriate machining centers, machining parameters, select appropriate cutting tools for CNC milling and turning equipment, set-up, program, and operate CNC milling and turning equipment.	PCD105	Computer Aided Manufacturing
2	create and validate NC part program data using manual data input (MDI) and automatically using standard commercial CAM package for manufacturing of required component using CNC milling or turning applications.	PCD105	Computer Aided Manufacturing
3	produce an industrial component by interpreting 3D part model/ part drawings using Computer Aided Manufacturing technology through programming, setup, and ensuring safe operation of Computer Numerical Control (CNC) machine tools.	PCD105	Computer Aided Manufacturing
4	create and demonstrate the technical documentation for design/ selection of suitable drive technologies, precision components and an overall CNC machine tool system for automation of machining operations using appropriate multi-axis CNC technology.	PCD105	Computer Aided Manufacturing
1	Use parametric 3D CAD software tools in the correct manner for making geometric part models, assemblies and automated drawings of mechanical components and assemblies.	PCD106	Geometric Modeling and Analysis
2	Use CAD software tools for assembly of mechanism from schematic or component drawing and conduct position/ path/ kinematic / dynamic analysis of a mechanism in motion.	PCD106	Geometric Modeling and Analysis
3	Evaluate design, analyze and optimize using commercial CAD, CAE software as black box for required mass properties/ stress, deflection / temperature distribution etc. under realistic loading and constraining conditions.	PCD106	Geometric Modeling and Analysis
4	Redesign in CAD and evaluate a mechanical product by using measured relevant materials properties.	PCD106	Geometric Modeling and Analysis
1	apply the procedure involved to solve a problem using Finite Element Methods.	PCD107	Finite Element Methods
2	develop the element stiffness matrices using different approach.	PCD107	Finite Element Methods
3	analyze a 2D problem using line, triangular, axisymmetric and quadrilateral element.	PCD107	Finite Element Methods

4	analyze a 3D problem using tetrahedral and hexahedral elements	PCD107	Finite Element Methods
1	design and simulate a system or process to meet the desired needs within realistic constraints and the same can be applied to automate the different processes in contemporary manufacturing systems	PCD204	Industrial Automation
2	design pneumatic and electro-pneumatic logic circuits	PCD204	Industrial Automation
3	use the different automation approaches and skills to solve the complex industrial problems necessary for contemporary engineering practice	PCD204	Industrial Automation
1	Analyze constructions and kinematic schemata of different types of machine tools.	PCD108	Machine Tool Design
2	Construct ray diagrams and speed spectrum diagrams for speed and feed box.	PCD108	Machine Tool Design
3	Develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools.	PCD108	Machine Tool Design
4	Apply the design procedures on different types of machine tool and/or machine tool components.	PCD108	Machine Tool Design
1	apply the principles of energy analysis, real gas behavior and thermodynamic property relations to solve thermodynamic problems.	PTH101	ADVANCED THERMODYNAMICS
2	analyze the micro approach to thermodynamics for defining models describing thermodynamic systems.	PTH101	ADVANCED THERMODYNAMICS
3	assess performance of thermodynamic systems in industry	PTH101	ADVANCED THERMODYNAMICS
4	develop conceptual designs of improved thermal systems	PTH101	ADVANCED THERMODYNAMICS
1	analyze the engine thermodynamic characteristics using fuel air cycles and combustion charts.	PTH103	INTERNAL COMBUSTION ENGINES
2	analyse S.I., C.I. and dual fuel engine performance.	PTH103	INTERNAL COMBUSTION ENGINES
3	analyse the effects of fuel composition on engine operation and mechanical limitations for ideal performance	PTH103	INTERNAL COMBUSTION ENGINES
4	analyse the air induction and fuel supply processes for both SI, CI engines.	PTH103	INTERNAL COMBUSTION ENGINES
5	analyse the effect of spark timing, valve timing and lift, cylinder dimensions, compression ratio, combustion ratio, combustion chamber design shape.	PTH103	INTERNAL COMBUSTION ENGINES
1	Solve the boundary layer equations for laminar flows.	PTH104	ADVANCED FLUID MECHANICS
2	obtained the exact solution to N-S equation for different geometries	PTH104	ADVANCED FLUID MECHANICS
3	Solve the equations for turbulent flow and its models	PTH104	ADVANCED FLUID MECHANICS
4	apply the numerical techniques for fluid flow problems.	PTH104	ADVANCED FLUID MECHANICS

1	Analyse, evaluate and compare the performances of complex vapor compression systems.	PTH202	ADVANCED FLUID MECHANICS
1	interpret mechanical drawings for components, assemblies and use parametric 3D CAD software tools in the correct manner for creating their geometric part models, assemblies and automated drawings.	UME411	COMPUTER AIDED DESIGN & ANALYSIS
2	create assembly of mechanism from schematic or component drawing and conduct position/ path/ kinematic / dynamic analysis of a mechanism in motion using CAD software tools.	UME411	COMPUTER AIDED DESIGN & ANALYSIS
3	evaluate design and create an optimized solution using commercial CAD, CAE software as black box for required analysis of mass properties/ stress, deflection / temperature distribution etc. under realistic loading and constraining conditions.	UME411	COMPUTER AIDED DESIGN & ANALYSIS
4	Assembly, drawings, analysis, evaluation of results, reflection and suggestions for design evaluation and improvement.	UME411	COMPUTER AIDED DESIGN & ANALYSIS
1	conduct a failure analysis for the design/sizing of mechanical components	UME408	MACHINE DESIGN-I
2	calculate stresses involved with static/ fatigue loading	UME408	MACHINE DESIGN-I
3	select the suitable materials and manufacturing considerations.	UME408	MACHINE DESIGN-I
4	represent machine elements with a free body diagram and solve for unknown reactions	UME408	MACHINE DESIGN-I
5	design and analyze a real engineering system through projects	UME408	MACHINE DESIGN-I
1	Calculate the output to input relation of any physical model in the form of a transfer function using block diagram reduction and signal flow graphs	UME410	MECHATRONIC SYSTEMS
2	Develop the block diagram of any mechatronic system after analyzing the key inputs, outputs, sensors, transducers and controllers of any physical device.	UME410	MECHATRONIC SYSTEMS
3	Analyze the key features of different type of controllers and develop a suitable controller to obtain the desired performance from the system. (will be partly covered before MST)	UME410	MECHATRONIC SYSTEMS
4	Develop the state-space representation of the physical model and analyze the performance and stability of the system in MATLAB environment.	UME410	MECHATRONIC SYSTEMS
5	Interface different sensors, actuators, micro-controllers and data acquisition cards of a given mechatronic device to the computer/laptop.	UME410	MECHATRONIC SYSTEMS
1	Analyze lacunae in existing layout of a shop floor in manufacturing and service organizations and develop an improved plant layout.	UME515	INDUSTRIAL ENGINEERING

2	Apply quality engineering tools for process control and improvement	UME515	INDUSTRIAL ENGINEERING
3	Develop a production schedule using information/ data from different functional areas.	UME515	INDUSTRIAL ENGINEERING
4	Determine the optimum time standards using work study principles and human factors in engineering.	UME515	INDUSTRIAL ENGINEERING
1	Apply the first and second laws of thermodynamics for complete thermal analysis of vapour power cycle.	UME501	APPLIED THERMODYNAMICS
2	Drive and Analyze Otto, Diesel and Dual cycle air standard thermal efficiencies.	UME501	APPLIED THERMODYNAMICS
3	Draw heat balance sheet of a boiler.	UME501	APPLIED THERMODYNAMICS
4	Determine the performance parameters of I.C. engines in an engine test rig.	UME501	APPLIED THERMODYNAMICS
5	Analyze simple Brayton cycle and determine the performance parameters of jet engine.	UME501	APPLIED THERMODYNAMICS
1	identify and analyze the functions and organization of industrial inspection	UME833	INSPECTION AND QUALITY CONTROL
2	apply and analyze the seven Ishikawa's tools and conduct quality cost analysis	UME833	INSPECTION AND QUALITY CONTROL
3	analyze various control charts for quality control of the different production processes	UME833	INSPECTION AND QUALITY CONTROL
4	evaluate through process capability studies if a given process is proficient in meeting customers specifications	UME833	INSPECTION AND QUALITY CONTROL
1	evaluate the power requirement of a vehicle under different operating conditions.	UME502	AUTOMOBILE ENGINEERING
2	calculate the energy losses and define the design parameters in different vehicle components	UME502	AUTOMOBILE ENGINEERING
3	solve the technical issues related to vehicle design and malfunctioning of different components through fault diagnosis and troubleshooting exercise of real case studies performed at the vehicle service stations.	UME502	AUTOMOBILE ENGINEERING
1	Apply engineering principle of mechanics to design motion transmission devices and flywheels	UME513	DYNAMICS & VIBRATIONS
2	Derive the dynamic model of real-life problems and verify the natural frequencies and mode shapes	UME513	DYNAMICS & VIBRATIONS
3	Determine the appropriate parameters for stability of a vehicle using the concept of gyroscopic action.	UME513	DYNAMICS & VIBRATIONS
4	Analyze two and multi-DOF physical systems analytically and validate using a commercial package	UME513	DYNAMICS & VIBRATIONS
1	select the suitable materials and manufacturing considerations.	UME711	MACHINE DESIGN -II
2	apply different theories for designing friction clutches and brakes.	UME711	MACHINE DESIGN -II
3	select bearings for a given load carrying capacity	UME711	MACHINE DESIGN -II

4	determine suitable module and specifications of gears from strength and wear considerations.	UME711	MACHINE DESIGN -II
5	design and analyze real engineering systems through research assignments.	UME711	MACHINE DESIGN -II
1	Determine the COP for different types of air refrigeration systems	UME803	REFRIGERATION AND AIR CONDITIONING
2	Determine the COP for vapour compression systems and heat pump	UME803	REFRIGERATION AND AIR CONDITIONING
3	Perform thermodynamic analysis of absorption refrigeration systems and steam jet refrigeration system	UME803	REFRIGERATION AND AIR CONDITIONING
4	Perform the load calculations for the different type of air conditioning systems	UME803	REFRIGERATION AND AIR CONDITIONING
5	Identify and determine the heating and cooling loads for air conditioning systems involving practical applications like; rooms/halls/restaurant/ theatre/auditorium etc	UME803	REFRIGERATION AND AIR CONDITIONING
1	Derive and apply thermodynamic and fluid terminology to turbo machines.	UME807	GAS DYNAMICS & TURBO MACHINES
2	Draw the velocity triangles in turbo machinery stages operating at design and off-design conditions.	UME807	GAS DYNAMICS & TURBO MACHINES
3	Determine methods to analyze flow behavior depending upon nature of working fluid and geometric configuration of turbo machine.	UME807	GAS DYNAMICS & TURBO MACHINES
4	Determine methodologies to evaluate solutions for efficiency, effectiveness and sustainability	UME807	GAS DYNAMICS & TURBO MACHINES
1	Calculate cutting forces and power requirement during single point cutting, multi-point cutting operations	UME705	MACHINING SCIENCE
2	Analyse the thermal and frictional aspects of machining parameters used in manufacturing industries	UME705	MACHINING SCIENCE
3	Develop mathematical models to predict material removal rate and surface quality for different process parameters in different non conventional machining methods	UME705	MACHINING SCIENCE
4	Design the conditions for maximum tool life and factors influencing surface quality, dimensional quality and material removal rate in machining	UME705	MACHINING SCIENCE
1	Calculate the output to input relation of any physical model in the form of a transfer function using block diagram reduction and signal flow graphs.	UME802	MECHATRONICS
2	Develop the block diagram of any mechatronic system after analyzing the key inputs, outputs, sensors, transducers and controllers of any physical device.	UME802	MECHATRONICS
3	Analyze the key features of different type of controllers and develop a suitable controller to obtain the desired performance from the system.	UME802	MECHATRONICS
4	Develop the state-space representation of the physical model and analyze the performance and stability of the system in MATLAB environment.	UME802	MECHATRONICS

5	Interface different sensors, actuators, micro-controllers and data acquisition cards of a given mechatronic device to the computer/laptop.	UME802	MECHATRONICS
1	Derive and analyses the various types of fluid flow governing equations.	UME831	COMPUTATIONAL FLUID DYNAMICS
2	Analyse the internal fluid flow phenomena of thermal and fluid system	UME831	COMPUTATIONAL FLUID DYNAMICS
3	Acquire enough knowledge to design of the engineering system using commercial computational code.	UME831	COMPUTATIONAL FLUID DYNAMICS
4	Design the thermal system using CFD.	UME831	COMPUTATIONAL FLUID DYNAMICS
1	Analyze the engine thermodynamic characteristics using fuel air cycles and combustion charts	UME834	INTERNAL COMBUSTION ENGINES
2	Evaluate and analyze the parameters in the engine for issues of power generation, fuel economy	UME834	INTERNAL COMBUSTION ENGINES
3	Analyze the air induction and fuel supply processes for both SI and CI engines	UME834	INTERNAL COMBUSTION ENGINES
4	analyse the effects of fuel combustion on engine operation and mechanical limitations for ideal performance.	UME834	INTERNAL COMBUSTION ENGINES
5	analyze the effect of spark timing, valve timing and lift, cylinder dimensions, compression ratio, combustion chamber design shape.	UME834	INTERNAL COMBUSTION ENGINES
1	Calculate the terrestrial solar radiation on an arbitrary tilted surface	UME839	RENEWABLE ENERGY SYSTEMS
2	Use flat plate solar collector mathematical model to calculate the efficiency and performance parameters of the same.	UME839	RENEWABLE ENERGY SYSTEMS
3	Determine maximum efficiency and maximum obtainable power from a given wind turbine	UME839	RENEWABLE ENERGY SYSTEMS
4	determine the plant efficiency of geothermal power plant.	UME839	RENEWABLE ENERGY SYSTEMS
5	Select the factors that are required to consider when selecting sites for tapping renewable energy.	UME839	RENEWABLE ENERGY SYSTEMS
6	determine maximum efficiency and maximum obtainable power from a given wind turbine	UME839	RENEWABLE ENERGY SYSTEMS
1	Calculate incident solar irradiance (diffuse and direct components) on flat and inclined surfaces for a given geographical location	UME853	SOLAR ENERGY ENGINEERING
2	Identify optimum heat transfer fluids for solar energy utilization	UME853	SOLAR ENERGY ENGINEERING
3	Select solar selective materials and optimum geometric configurations for harnessing solar energy.	UME853	SOLAR ENERGY ENGINEERING
4	Draw thermal resistance diagrams relevant to the constituents elements of a given solar thermal system.	UME853	SOLAR ENERGY ENGINEERING
5	Evaluate the thermal and optical performance of PV and solar thermal systems.	UME853	SOLAR ENERGY ENGINEERING

1	model the material removal rate and tool wear rate in various micro machining processes	UPE801	MICRO MACHINING PROCESSES
2	analyze the processes and evaluate the role of each process parameter during micro machining of various advanced materials ( will be partly covered before MST)	UPE801	MICRO MACHINING PROCESSES
3	analyze the processes and evaluate the role of each process parameter during micro machining of various advanced materials ( will be fully covered after MST)	UPE801	MICRO MACHINING PROCESSES
4	Design the requirements to achieve best quality of machined surface while micro machining of various industrial engineering materials	UPE801	MICRO MACHINING PROCESSES
1	analyze the fundamental theory of operations and production management	UME836	OPERATIONS MANAGEMENT
2	analyze forecasting problems or issues faced by service and manufacturing organizations	UME836	OPERATIONS MANAGEMENT
3	solve problems of materials requirements planning, aggregate production planning	UME836	OPERATIONS MANAGEMENT
4	analyze inventory management problems	UME836	OPERATIONS MANAGEMENT
1	Develop physical prototype applying the fundamental concepts of rapid prototyping	UME605	RAPID MANUFACTURING
2	Develop a solid model applying the concepts of transformations & solid modelling	UME605	RAPID MANUFACTURING
3	Analyze different rapid prototyping systems based on their principles of operation and materials used	UME605	RAPID MANUFACTURING
4	Analyze & detect the errors in STL files and implement the repair algorithms associated with the errors.	UME605	RAPID MANUFACTURING
5	Calculate layer thickness, orientation and shrinkage compensation in different layering techniques.	UME605	RAPID MANUFACTURING
1	explore opportunities to critically analyse existing information systems to assess scope of improvement	UPE832	MANAGEMENT INFORMATION SYSTEM
2	use process modeling tools for the analysis and design of business processes with regards to information systems	UPE832	MANAGEMENT INFORMATION SYSTEM
3	develop plans for information system development	UPE832	MANAGEMENT INFORMATION SYSTEM
4	design information systems structure to improve business process effectiveness and efficiency.	UPE832	MANAGEMENT INFORMATION SYSTEM
5	integrate business processes through the use of data information systems and improve functional integration in organizations	UPE832	MANAGEMENT INFORMATION SYSTEM
1	identify and formulate the desired robotic design specifications for a particular application.	UME805	ROBOTICS ENGINEERING
2	develop and simulate the forward kinematics model using D-H conventions.	UME805	ROBOTICS ENGINEERING
3	develop the inverse kinematics model of a serial manipulator.	UME805	ROBOTICS ENGINEERING

4	develop and analyze the mathematical model for robotics trajectory planning, resolved motion rate control and dynamics for a given serial robotic manipulator.	UME805	ROBOTICS ENGINEERING
5	apply the joint- and Cartesian-based schemes to control the manipulators in different applications.	UME805	ROBOTICS ENGINEERING
1	Create the different wireframe primitives using parametric representations.	PCD202	Computer Aided Design
2	Apply geometric transformations on the created wireframe, surface and solid models.	PCD202	Computer Aided Design
3	Create surface primitives using parametric modeling.	PCD202	Computer Aided Design
4	Create the different solid primitives using the different representation schemes.	PCD202	Computer Aided Design
1	Apply the concepts of coordinate transformations for development of arm equation and subsequently the inverse kinematics model for given serial manipulator.	PCD209	Robotics
2	Apply the concepts of robotic workspace analysis for design of robotic manipulator for required work cell applications.	PCD209	Robotics
3	Design and analyze the workcell environment for given robotic manipulator configuration and workcell devices for required integrated industrial application.	PCD209	Robotics
1	Develop the state-space representation, canonical forms and solutions of the LTI state equations of any MIMO system	PCD208	Modern Control of Dynamic Systems
2	Solve the regulation as well as tracking problem in various engineering applications using pole placement approach.	PCD208	Modern Control of Dynamic Systems
3	Design observers and compensators, when the state variable of the physical system are not measurable.	PCD208	Modern Control of Dynamic Systems
4	Formulate an optimal control problem and solve LQR design problem.	PCD208	Modern Control of Dynamic Systems
1	Apply the concepts of transformations & solid modeling in solid model preparation.	PCD212	Rapid Prototyping
2	Identify layer thickness, build time and orientation in Rapid Prototyping.	PCD212	Rapid Prototyping
3	Recognize the STL file errors and implement the different repair algorithms associated with them.	PCD212	Rapid Prototyping
4	Evaluate different rapid prototyping systems based on their principles of operation and applications.	PCD212	Rapid Prototyping
5	Identify a material for particular application based on product requirement and material characteristics.	PCD212	Rapid Prototyping
1	Acquire the knowledge of various types of fluid flow governing equations.	PCD312	Computational Fluid Dynamics
2	Analyze the internal fluid flow phenomena of thermal and fluid system.	PCD312	Computational Fluid Dynamics
3	Acquire enough knowledge to design of the engineering systems using commercial computational code.	PCD312	Computational Fluid Dynamics
4	Design the thermal system using CFD.	PCD312	Computational Fluid Dynamics



1	Model of rigid bodies, structural systems, hydraulic systems, thermal systems, electronic and mechatronic systems.	PCD315	Modelling and simulation of Dynamic Systems
2	Understand and model mechanisms, manipulators, vehicles etc.	PCD315	Modelling and simulation of Dynamic Systems
3	Analyze and model of different control strategies in physical domain. (will be partly covered before MST)	PCD315	Modelling and simulation of Dynamic Systems
4	Model welding dynamics and plant water dynamics.	PCD315	Modelling and simulation of Dynamic Systems
5	Realize thermal modelling of twin tube shock absorber and car cabin exposed to sunlight.	PCD315	Modelling and simulation of Dynamic Systems
1	Solve the design problems of different type of transfer mechanisms	PCD206	Computer Integrated Manufacturing Systems
2	Perform design and analysis of automated storage and retrieval system	PCD206	Computer Integrated Manufacturing Systems
3	evaluate the space requirements of different storage systems	PCD206	Computer Integrated Manufacturing Systems
4	Design the workstation requirement for unattended operations and automated production systems	PCD206	Computer Integrated Manufacturing Systems
5	optimize the number of machines required for machine cell in a given production system	PCD206	Computer Integrated Manufacturing Systems
1	Develop the conduction equations for multi-dimensional heat transfer problems like cylinder, sphere, rectangular pipe etc	PTH204	Advanced Heat Transfer
2	Develop the correlations for convection heat transfer problems	PTH204	Advanced Heat Transfer
3	Develop and learn the computational techniques for the heat transfer problems	PTH204	Advanced Heat Transfer
4	4 Develop and test new heat transfer fluids like; nanofluids	PTH204	Advanced Heat Transfer
1	design system/process/components by applying the guidelines of codes, standards and catalogs	PTH207	ADVANCED POWER PLANT ENGINEERING AND INDUSTRIAL UTILITY
1	Estimate the terrestrial solar radiation on an arbitrary tilted surface.	PTH206	Applied Solar Energy
2	Use flat plate solar collector mathematical model to calculate the efficiency and performance parameters of the same	PTH206	Applied Solar Energy
3	Use flat plate solar collector mathematical model to calculate the efficiency and performance parameters of the same.	PTH206	Applied Solar Energy
4	Determine the useful gain and thermal efficiency of concentrating collectors.	PTH206	Applied Solar Energy
5	Explain the selection and installation of evacuated tube collector systems.	PTH206	Applied Solar Energy
6	Perform heat and mass transfer analysis for simple solar still	PTH206	Applied Solar Energy

1	Determine and analyse proximate and physical properties of a given fuel sample	PTH212	Fuels and Combustion
2	Determine and analyse heat balance sheet of a boiler	PTH212	Fuels and Combustion
3	Design of a stack/chimney	PTH212	Fuels and Combustion
4	Analyse flue gas samples and determine combustion stoichiometry	PTH212	Fuels and Combustion
5	Determine and analyse properties of liquid and gaseous fuels	PTH212	Fuels and Combustion
1	Apply the designing methods of heat exchangers	PTH323	Two-Phase Flow and Heat Transfer
2	Design the heat exchangers for various thermal applications where fluid does not change its phase	PTH323	Two-Phase Flow and Heat Transfer
3	Design the heat exchangers for various thermal applications where fluid undergo phase change	PTH323	Two-Phase Flow and Heat Transfer
4	Investigate the performance of the compact heat exchangers	PTH323	Two-Phase Flow and Heat Transfer
1	Analyse thermal, metallurgical aspects during solidification in casting and welding and their role on quality of cast and weld objects.	PPI312	Metal Casting and Joining
2	Design the gating and riser system needed for casting and requirements to achieve defect free casting.	PPI312	Metal Casting and Joining
3	Analyse the welding process behavior for common and newer welding techniques.	PPI312	Metal Casting and Joining
4	Understand requirements to achieve sound welded joint while welding different similar and dissimilar engineering materials.	PPI312	Metal Casting and Joining
1	Select a suitable strengthening mechanism for a given alloy composition and application	PPI325	Advanced Materials Technology
2	Analyze the type of failure and reasons thereof for an alloy system under different loading conditions	PPI325	Advanced Materials Technology
3	Select a suitable heat treatment/ case hardening for a given alloy application	PPI325	Advanced Materials Technology
4	Identify the key characteristics, processing and applications of composites and AHSS.	PPI325	Advanced Materials Technology
1	Model the material removal in various modern manufacturing processes	PPI201	Advanced Manufacturing Processes
2	Analyze the processes and evaluate the role of each process parameter during machining of various advanced materials	PPI201	Advanced Manufacturing Processes
3	Solve the various problems for the given profiles to be imparted on the work specimens	PPI201	Advanced Manufacturing Processes
4	Select the best process out of the available various advanced manufacturing processes for the given job assignment.	PPI201	Advanced Manufacturing Processes
5	understand requirements to achieve maximum material removal rate and best quality of machined surface while machining various industrial engineering materials.	PPI201	Advanced Manufacturing Processes

1	Understand the fundamental theory of operations and production management.	PPI204	Operations Management
2	Solve various kinds of problems or issue faced by service and manufacturing industries like economic consideration, optimum utilization of resources, productivity solve various kinds of problems or issue faced by service and manufacturing industries	PPI204	Operations Management
3	Solve various kinds of problems or issue faced by service and manufacturing industries for production planning, inventory management and control	PPI204	Operations Management
4	Get the solutions for material requirement planning	PPI204	Operations Management
1	Decide yielding of a material according to different yield theory for a given state of stress	PPI313	Metal Forming
2	Develop the kinematically admissible velocity field for different forming processes	PPI313	Metal Forming
3	Analyze the different bulk metal forming process mechanics using different analysis approach and calculate the force, power requirements etc.	PPI313	Metal Forming
4	Evaluate the effect of process parameters on the process mechanics during bulk metal forming	PPI313	Metal Forming

## POSTGRADUATE PROGRAM – M.Sc. BIOTECHNOLOGY (2 years)

### PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

1. The programme focuses on basic understanding in the diverse fields of traditional and modern biotechnology with emphasis on industrial applications and product developments.
2. The programme is aimed towards the scientific research with focus on cell and molecular biology, biochemistry, microbiology, immunology and modern bioengineering subjects.
3. It also gives emphasis on skill development in various fields of biotechnology in addition to research training which make students to plan, design, execute, analyze, and solve industrial and research associated problems.
4. The objective of this programme is to make students competitive enough to make successful career in industries and research institutes/universities.

### PROGRAMME OUTCOMES (PO's)

After successful completion of this MSc programme in Biotechnology, students will:

1. Comprehend and integrate theoretical and practical skills in basic and applied disciplines of biotechnology.
2. Acquire knowledge to develop a research plan in which research question, hypothesis, experimental set-up and data analysis are described in relation to relevant literature.
3. Be able to design new biotechnological products or processes by applying knowledge of different disciplines of biotechnology in an integrated manner.
4. Be trained enough to take employment in diverse areas of biotechnology as well as for further higher studies.

### PIM101: BASIC MATHEMATICS (LTP-310/ Credits-3.5)

**CO:** The objective is to develop basic computing skills and application of quantitative and statistical operations required for biological studies and rationalization of experimental designs

### CLO:

Students will be able to:

1. Acquire mathematical concepts in continuous learning and connecting ideas like numerical analyses, calculus, and coordinate geometry to other subjects.
2. Learn various applications of mathematics

### **PBT101: INTRODUCTION TO LIFE SCIENCES (LTP-310/Credits-3.5)**

**CO:** The objective of this course is to enable the students to gain knowledge of diversity of life and to understand various aspects of living systems. The course will provide understanding of basic organization of plant and animal systems at cellular, tissue and organ levels and their specialized functions.

#### **CLO:**

Students will be able to:

1. Comprehend diverse eukaryotic systems, and various biological processes.
2. Apply the basic knowledge of animal and human physiology in biomedical sciences.
3. Analyze basic concepts of genetics and their applications in molecular biology.
4. Comprehend some important physiological processes in plants, and the role of hormones

### **PBT108: MICROBIOLOGY (LTP-302/ Credits: 04)**

**CO:** The objective of this course is to make students understand the existence of microbial world and diversity along with their origin and scope in present day life.

#### **CLO:**

Students will be able to:

1. Recognize and compare the structure and function of microbes.
2. Check microbial contamination in environmental samples.
3. Demonstrate aseptic microbiological techniques in the laboratory.
4. Control microbial contamination and take safety measures.
5. Apply norms of biosafety practices in various set ups.

### **PBT103: BIOCHEMISTRY (LTP-312/Credits-4.5)**

**CO:** Objective of studying biochemistry is to know how the collection of thousands inanimate molecules that constitute living organisms interact to maintain and perpetuate life governed solely by the physical and chemical laws as applicable to the non-living things.

#### **CLO:**

Students will be able to:

1. Explain the structure-function relationships of biomolecules.

2. Characterize properties of enzymes and their kinetics, understand their role as biocatalysts involved in biochemical transformations.
3. Correlate how different signals perceived by the organisms are converted into biochemical information which drives different functions of living systems.
4. Comprehend various metabolic pathways through which the biomolecules transform from one form to another and generate energy for carrying out the life processes.

**PBT104: CELL AND MOLECULAR BIOLOGY (LTP-302/Credits: 04)**

**CO:** To understand the structure and function of cell and cell membranes and macromolecular components of cells and their functions, general principles of gene organization and expression in prokaryotic and eukaryotic organisms, basic pathways and mechanisms in biological energy transduction and cell cycle control and relate properties of cancerous cells to mutational changes in gene function.

**CLO:**

Students will be able to:

1. Comprehend the cellular architecture with fine details of various intracellular organelles.
2. Interpret molecular mechanisms involved at various stages of cell cycle and its regulation.
3. Correlate between signal molecules and their role in various cellular activities.
4. Analyze architecture of the genomes, genes, and the flow of genetic information through replication, transcription, translation.
5. decipher regulation of gene expression, and its influence on various stages of develop

**PBT109: BIO-TECHNIQUES AND INSTRUMENTATION (LTP-312/Credits: 4.5)**

**CO:** The course is aimed to acquaint the students with various techniques used in biological sciences and the emerging areas of biotechnology along with underlying principles. The course also aims to make students learn about modern instruments for various analytical works.

**CLO:** Students will be able to:

1. comprehend the principles of various bio analytical techniques
2. Learn centrifugation and electrophoretic techniques involved in isolation, purification and analysis of biomolecules.
3. Learn spectrophotometric techniques for qualitative and quantitative analyses of biomolecules.
4. Learn various microscopic i.e. imaging techniques to study structural and morphological features.
5. adopt the facile bio analytical techniques in various biotechnological applications

**PHU022: PROFESSIONAL COMMUNICATION (LTP-210/Credits: 2.5)**

**Course Objective:** To provide the students with the essential skills required for effective communication and to provide a comprehensive view of business communication and its role in the corporate environment

**CLO:**

Students will be able to:

1. Understand and demonstrate the use proper writing techniques relevant to the present day technological demands, including anticipating audience reaction.
2. Write effective and concise letters and memos, prepare informal and formal reports, proofread and edit copies of business correspondence.
3. Develop interpersonal skills that contribute to effective personal, social and professional relationships.

**PBT207: BIostatistics AND COMPUTATIONAL BIOLOGY (LTP-312/Credits: 4.5)**

**CO:** This course will encompass the methodology and theory of statistics as applied to problems in the field of life sciences. The course will provide students with basic understanding and application of computational biology.

**CLO**

Students will be able to:

1. organize, summarize and display biological data
2. statistical tools to analyze public health, clinical and biological research problems
3. apply concepts of probability and probability distributions for analyzing biological data
4. develop algorithms to solve complex biological problems
5. apply HMM and related algorithms in bioinformatics

**PBT302: BIOINFORMATICS (LTP-312/Credits: 4.5)**

**CO:** The objective of this course is to provide students with basic understanding and applications of bioinformatics. The course will provide the basic concepts behind the sequence and structural alignment, database searching, protein structure prediction and computer-based drug designing.

**CLO:**

Students will be able to:

1. apply key concepts of different bioinformatics tools
2. analyse sequence and structure bio-macromolecule data
3. apply the knowledge of bioinformatics in the biotechnology research and industry

**PBT209: FOOD PROCESSING (LTP-302/Credits: 4.0)**

**CO:** The objective of this course is to provide knowledge on various processing Technologies of food and food products, preservation, long term storage and food safety aspects.

**CLO:**

Students will be able to:

1. Acquire knowledge of food and its components, importance of handling and packaging.
2. Apply processing and quality analysis techniques in food processing.
3. Acquire knowledge about purified forms of foods and different processed food production.
4. Comprehend industrial operations in food, role of microbes, enzymes and different effects of processing on the components of foods.
5. acquire knowledge about the small scale industries set-up in different food group

**PBT204: GENETIC AND METABOLIC ENGINEERING (LTP-302/Credits: 4.0)**

**CO:** The objective of this course is to make students learn about basic techniques of recombinant DNA technology such as molecular cloning, gene manipulation and producing GMOs. This will also make students learn about fundamentals and applications of metabolic engineering.



**CLO:**

Student will be able to:

1. Comprehend the importance of various DNA modifying enzymes in developing various molecular techniques used in rDNA technology.
2. Select the suitable hosts for the individual vectors for different purposes.
3. Know the uses of restriction and other enzymes in molecular cloning, PCR and genetic manipulations.
4. Carryout construction and screening of the genomic and cDNA libraries.
5. Design experiments for expression of the cloned gene (s) for useful products.
6. apply the principles of metabolic engineering for novel products

**PBT210: IMMUNOLOGY AND IMMUNOTHERAPY (LTP-312/Credits: 4.5)**

**CO:** The objective of this course is to provide students with detail understanding of different cells of the immune system and their role in immune protection and application of immunological techniques. The course will provide knowledge about role of immune system in pathogenesis of infectious diseases, cancer, autoimmune disease, AIDS.

**CLO:**

Students will be able to

1. Explain the role of immune cells and their mechanism in body defense mechanism.
2. Apply the knowledge of immune associated mechanisms in medical biotechnology research.
3. Adopt immunological techniques for industrial uses.
4. Demonstrate the association of immune system with cancer, autoimmunity, transplantation and infectious disease.
5. find out new vaccine target and develop strategy to design new vaccine

**PBT206: MICROBIAL TECHNOLOGY (LTP-302/Credits: 4.0)**

**CO:** The course will impart a comprehensive knowledge and understanding of technological processes involved in biotechnological industries exemplifying a wide range of manufacturing and production of commercially important Bio products

**CLO:**

Students will be able to:

1. comprehend various microorganisms in the biosphere, their behavior and beneficial effects
2. Particularly their relevance with regard to industrial applications.
3. Correlate the role of microorganisms in biogeochemical cycling and various bio-transformations.
4. Apply use of various microorganisms in food and fermentation industries.
5. recognize the growing importance of the microbes in alternative renewable energy source

**PBT306: ANIMAL AND STEM CELL TECHNOLOGY (LTP-312/Credits: 4.5)**

**CO:** The objective of this course is to introduce students to develop basic aseptic skills for vertebrate cell culture and the maintenance of cell lines and in vitro application of cell and molecular techniques

**CLO:**

Students will be able to:

1. Explain the fundamental scientific principles that underlie cell culture.
2. Acquire knowledge for isolation and growth of cells.
3. develop proficiency in establishing and maintaining of cell lines
4. apply the concept of stem cell technology in biomedical research

**PHU301: ENTREPRENEURSHIP AND IPR (LTP-310/ Credits-3.50)**

**CO:** Students will be able to demonstrate and develop awareness of personal as well as external resources with a view to successfully launching and subsequently managing their enterprises. They will be able to develop skills in operations, finance, and marketing and human resource management and be aware of rights resulting from intellectual property rights, infringement of intellectual property rights (with particular emphasis on patent infringement and plagiarism) and free use of intellectual property rights

**CLO:**

Students will be able to:

1. assess their personal characteristics and interests to that of the “successful” entrepreneur,
2. Identification and assess sources of support for small businesses and entrepreneurs.
3. evaluate methods of entering an entrepreneurship venture – including but not limited to starting a new venture, buying an existing business, or becoming a franchisee

**PBT202: BIOPROCESS TECHNOLOGY (LTP-302/ Credits: 4.0)**

**CO:** To acquire knowledge on reaction engineering systems with emphasis on bioreactor design and operation and analysis of kinetics in biochemical engineering reactions along with separation and purification of desired products.

**CLO:**

Students will be able to:

1. apply the concepts of basic chemical engineering principles in a bioprocess
2. produce bio-products on an industrial scale using fermenters
3. operate and optimize process parameters in a for producing industrial products

**PBT304: PHARMACEUTICAL TECHNOLOGY (LTP-302/ Credits: 04)**

**CO:** To acquire knowledge about the new drug discovery, development and approval process and drug manufacturing and its quality control in pharmaceutical industry.

**CLO:**

Students will be able to:

1. Explain the strategies and various steps of new drug discovery process.
2. Explain the pharmacodynamics and pharmacokinetics of drugs.
3. apply the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones
4. carry out the quality control procedures in the production of various biopharmaceuticals
5. Apply the knowledge of natural products in the development of drugs.

**PBT305: PLANT BIOTECHNOLOGY ( LTP-302/Credits:04)**

**CO:** The course will enable the students to acquire knowledge about various techniques like micro propagation, single cell culture, suspension culture, protoplast culture, hairy root culture and various techniques of recombinant DNA technology to produce genetically modified organisms with novel characters.

**CLO:**

Students will be able to:

1. familiarize with organization of PTC Lab., aseptic manipulations and learn techniques of culturing tissues, single cells, protoplast and another culture, hairy root culture and germplasm conservation

2. Undertake large scale *in vitro* propagation of plants and plan commercial production through micro propagation
3. Generate plants with desirable/novel traits through genetic manipulations using different methods of gene transfer and marker associated selections.
4. recognize the importance of plant secondary metabolites, their production, and commercial

#### **ELECTIVE- I**

#### **PBT311: GENOMICS, METAGENOMICS AND PROTEOMICS (LTP-302/Credits: 4.0)**

**CO:** The objective of this course is to teach genomes, metagenomes and

Proteomes their characteristics and sequencing to the students and their applications in comparative genomics and transcriptomics

#### **CLO:**

Students will be able to:

1. Comprehend various aspects of genomes of different types of organisms.
2. Design strategies for genome sequencing, comparative genomics and transcriptomics using microarray technology.
3. use genome mapping tools
4. Apply metagenomics and different methodologies in proteomics as well as structural proteomics.
5. design experiments to perform proteomic analysis

#### **PBT312: MOLECULAR FARMING (LTP-302/Credits: 4.0)**

**CO:** The students will learn about molecular farming an emerging branch of

plant biotechnology and wide range of products for molecular farming such as carbohydrates, fats, proteins, secondary products and commercially important molecules using plant systems as 'bioreactors'.

#### **CLO:**

Students will be able to:

1. Recognize the overall importance of plant molecular farming.
2. develop strategies for modification of various plant-made products such as carbohydrates, lipids, proteins and other novel molecules
3. generate transgenic plants that can produce commercially important proteins and enzymes

4. Design strategy for production of biodegradable plastics in plants.
5. apply steps involved in downstream processing of plant-made products

**PBT313: MOLECULAR MEDICINE AND DIAGNOSTICS (LTP-302/Credits: 04)**

**CO:** To provide an advanced understanding of the molecular basis of the pathogenesis, diagnosis and treatment of human diseases. To describe and discuss topics related to infectious diseases, chronic diseases, genetic diseases, endocrine disorders, malignancy and diseases arising from abnormal immune responses

**CLO:**

Students will be able to:

1. receive insights into the translational and clinical aspects of science and conversely students in clinical medicine
2. Gain new insights into molecular mechanisms, disease models and preclinical work.
3. comprehend deleterious effects of reactive oxygen species and the remedial measures

**PBT391: SUMMER ASSIGNMENT/INDUSTRY VISIT (LTP-000/Credits: 02)**

**CO:** The purpose of this training is providing exposure to the working environment of various industries and research institution. During this period, the students will get hands on training in the diverse areas of biotechnology

**CLO:**

The students will be able to:

1. adapt to the varying working environment in industry and research institute
2. design experiments pertaining to different areas of biotechnology
3. analyze and interpret the experimental data
4. communicate the scientific data/outcomes to the peers

**PBT491: SEMINAR (LTP-000/Credits: 02)**

**CO:** The students will choose a topic of their interest and do a literature survey and compile information with latest update and also find gaps or lacunae to plan for next series of experiments to be conducted to fill the gaps as a major research project. The students will acquire skill to write, compile and analyze data and present the detailed technical or scientific report.

**CLO:**

The students will be able to:

1. Carry out literature survey and compile existing data and information.
2. Formulate a research problem in research laboratory.
3. Design experiments to solve research problem.
4. Make a presentation of compiled data and its interpretation to a meaningful conclusion.
5. acquire presentation and oral communication skills of scientific information and data

**PBT492: MAJOR RESEARCH PROJECT (LTP-000/ Credits: 10.0)**

**CO:** The semester project is aimed to impart an in-depth and thorough training on some specific research problems. Such exposures would enable the students to address the various real-time challenges prevalent in different areas of biotechnology. The students will gain knowledge of different experimental skills associated with biochemistry, microbiology, molecular genetics, genetic engineering, immunology and bioinformatics. The students acquire experience and knowledge to work in professional setup.

**CLO:**

The students will be able to:

1. work in a team
2. Identify a problem in biotechnology based industry.
3. formulate a research problem in research laboratory
4. Design experiments to solve the industrial/research problem.
5. Compile and/or interpret the industrial data.
6. analyze and interpret the experimental data

# **CIVIL ENGINEERING**

## **COURSE LEARNING OUTCOMES** **(CLO) -2018**

## 2<sup>nd</sup> Semester

<b>UES009: Mechanics</b>
1. Determine resultants in plane force systems
2. Identify and quantify all forces associated with a static framework
3. Solve problems in kinematic and dynamic systems

## 3<sup>rd</sup> Semester

<b>UES010: Solids &amp; Structures</b>
Evaluate axial stresses and strains in various determinate and indeterminate structural systems
Draw Shear Force Diagram and Bending Moment Diagram in various kinds of beams subjected to different kinds of
Evaluate various kinds of stresses (axial, bending, torsional and shearing) in various structural elements due to different type of external loads.
Determine deformations and deflections in various kinds of beams and trusses
Evaluate the principal stresses/strains and maximum shear stresses/strains for generalized stress element
<b>UCE307: Building Materials</b>
Evaluate various properties of concrete
Evaluate various properties of the basic construction materials such as brick, stone timber, metals
Evaluate the properties of miscellaneous materials including epoxies, asbestos, bitumen, paints, distempering, materials for structural repairs
Perform various quality control tests for the various civil engineering materials by performing different lab tests on materials.
<b>UCE306: Architecture Drawing &amp; Building Construction</b>
Plan and draw constructional details of different building components
Capable of working with an architect and contractor
Prepare building plans and other components for a project
Capable of supervise building constructions

## 4<sup>th</sup> Semester

<b>UCE403: Surveying</b>
Survey an area under various topography and obstructions
Prepare the plan or map of the area surveyed.
Analyse, report and where appropriate distribute the survey errors
Set out curve and building lay out.
Perform instruments checks to ensure they meet the specifications
<b>UCE404: Structural Analysis</b>
Calculate deformation of statically determinate structures using geometric and energy methods.
Analyse statically indeterminate beams using classical and conventional methods
Develop qualitative diagrams showing the displaced shape, bending moments and support reactions for an indeterminate plane frame
Draw influence line diagrams for statically determinate beams and frames.



### UCE508: Design of Concrete Structures-I

Design and detail flexural elements such as beams, slabs etc.
Design the flexural member for shear ,bond and torsion
Design and detail compression members
Design other elements such as footings, stair-case

## 5<sup>th</sup> Semester

<b>UCE501: Soil Mechanics</b>
Determine the index and engineering properties of soil
Evaluate the influence of water on engineering properties of soil
Evaluate the compressibility characteristics of soils in engineering practices
Determine the shear strength of soils by various methods
<b>UCE401: Hydrology &amp; Groundwater</b>
Recognize various components of hydrologic cycle and evaluate water availability based on water budget equation
Perform analysis on precipitation, evaporation and infiltration data for various applications.
Estimate runoff generated from watershed based on empirical and hydrograph analysis.
Estimate discharge of rivers using various methods
Apply principles of flood frequency analysis and flood routing to forecast floods
Apply hydraulic principles of groundwater flow in different geological formations.
<b>UCE507: Advanced Structural Analysis</b>
Analyze two hinged and three hinged arches and cables
Develop stiffness matrices of different types of structures using System Approach and subsequently analyze the structures.
Develop system stiffness matrix using transformation matrices and subsequently analyze the structures using Element Approach.
Develop system flexibility matrices for different types of structures using System Approach and subsequently analyze the structures.
Develop system flexibility matrix using force transformation matrices and subsequently analyze the different structures using Element Approach
<b>UCE509: Transportation Engineering-I</b>
Quantify the specifications of various road construction materials required
Perform geometric design of highways and expressways
Perform analysis and design of flexible and rigid pavements
Address highway maintenance, drainage and economic issues
Perform the traffic studies necessary before making changes to or designing new road Infrastructure
<b>UCE510: Construction Management</b>
Perform the rate analysis for the various construction activities
Estimate the cost for the building and the road projects
Perform the project planning, scheduling, time-cost optimization, resource allocation and project controlling
Prepare the contract documents for a given project
<b>UCE592: Survey Project</b>
Perform basic surveying on a considerably difficult hilly terrain
Set up traverse stations, base-line measurements, fly leveling, detailing, and contouring
<b>UCE609: Design of Steel Structures-I</b>
Design the bolted and welded connections between various structural components

Design compression members and column bases with and without eccentric loading
Find out ultimate load of the structural systems using plastic analysis
Design flexural members

## 6<sup>th</sup> Semester

<b>UCE607: Foundation Engineering</b>
Design and analyze problems related to shallow and machine foundations
Analyze lateral earth pressure for design of earth retaining structures
Assess stability of natural/man-made slopes under varying in-situ material properties
Design and analyze problems related to pile and well foundations
<b>UCE603: Hydraulic Engineering</b>
Determine the runway orientation and the runway length as per FAA & ICAO guidelines
Design the airport pavements including air-side marking & lighting as per ICAO & FAA guidelines
Evaluate pavement and learn the concept of pavement maintenance management system
Employ Railway Track specifications and perform geometric design of the railway track.
Design of turnout and crossings as per the Indian Railways
<b>UCE 605:Transportation Engineering-II</b>
Determine the runway orientation and the runway length as per FAA & ICAO guidelines
Design the airport pavements including air-side marking & lighting as per ICAO & FAA guidelines
Evaluate pavement and learn the concept of pavement maintenance management system
Employ Railway Track specifications and perform geometric design of the railway track.
Design of turnout and crossings as per the Indian Railways
<b>UCE 608:Design of Concrete Structures-II</b>
Analyze and design R.C.C domes and beams curved in Plan
Design RCC water tanks
Design Various types of Combined footing
Design cantilever type retaining walls
<b>UCE606: Water and Wastewater Engineering</b>
Characterize water and wastewater
Design a water supply system
Conceive and design a water treatment plant
Design sewerage system
Conceive and design a sewage treatment plants
<b>UCE692: Group Design Project</b>
Function as a member of the design team.
Develop the general arrangement drawings.
Produce detailed structural design & drawings and viable construction sequence.
Produce a bill of quantities and calculate approximate construction cost

## 7<sup>th</sup> Semester

<b>UCE 701: Ground Improvement</b>
Apply the concept of soil reinforcement
Perform ground improvement based on grouting and exclusion techniques
Design earth retaining structures, diaphragm walls and stone columns

**UCE 725: Advanced Construction Materials**

Identify supplementary cementing materials

Enumerate characteristics of FRC, SCC, HPC

Experiment to know the effect of addition of waste material and by product on concrete

**8<sup>th</sup> Semester**

**UCE 844: Remote Sensing & GIS**

Process the remotely sensed data for various field applications

Interpret and classify the remotely sensed data and prepare the land use and land cover map. (part)

Handle DEM data and be able to prepare contours and topographical maps.

Delineate the watershed and prepare the stream network of an area.

Use spatial information, collected through remote sensing, for the benefits of end users

**UCE 805: Design of Steel Structures -II**

Analyse and design plate girder bridges and truss bridges

Analyse and design different components of industrial buildings

Design tubular and aluminum structures

Analyse and design transmission line towers

**UCE804: Seismic Analysis and Design**

Evaluate the dynamic properties of single and multi-degree of freedom systems

Evaluate the dynamic properties for SDOF system subjected to harmonic, impulse and arbitrary loading

Evaluate seismic load for a building using equivalent static load procedure as per IS codes

Evaluate seismic load for a building using dynamic analysis as per IS codes

Perform ductile detailing of buildings, and design of shear walls as per IS code

**UCE806: Design of Hydraulic Structures**

Work out water requirement of crops.

Design lined and unlined channels for distribution water

Learn the function, components and design of headworks

Learn the function, components and design of canal regulation works and related hydraulic structures

Learn different types of cross drainage works and their design aspects

**UCE723: Groundwater Engineering**

Learn the principles of groundwater flow and its representation in mathematical equation.

Estimate the discharge in well for different aquifers.

Learn the method of well construction

Learn the source and mechanism of contaminant transport in groundwater

Learn the methods of groundwater of exploration and the reasons of groundwater fluctuation.

**UCE846: Soil Dynamics and Machine Foundation**

Know theoretically how to evaluate dynamic properties of soils by geotechnical and geophysical methods

Understand the stress-strain behaviour of cyclically loaded soils.

Evaluate the liquefaction potential of soil deposits.

Perform analysis and design of retaining walls and dynamic loading.

Perform analysis and design of machine foundations

**UCE845: Prestressed Concrete**

Specify and characterize the materials required for prestressed concrete structures and various methods of prestressing.
Calculate losses in various pre-stressed members.
Analyze prestressed concrete members for flexure and their flexural strength.
Design various prestressed concrete structures for bending, axial tension, bond and bearing.
Evaluate shear and torsional resistance of pre-stressed concrete members and perform check for deflection criteria.
<b>UCE805: Industrial Waste Management</b>
Analyze various Environmental issues of industries
Identify suitable methods of treatment and disposal systems of industrial waste to comply with emission
Learn various methods used for controlling industrial based on regulatory requirements
Learn about environmental standards and Environmental management systems
<b>UCE832: Geo-Techniques</b>
Design the cantilever and anchored sheet pile
Design the bracing system in open cuts and anchoring
Apply design aspects of earth dams.
Design the foundations on expansive soils.
Design the well point system for deep excavations
<b>UCE724: Site Organization and Safety Management in Construction</b>
Execute various preparatory steps involved in construction and project execution at site
Perform various organizational activities involved in project management at site
Work out safety provisions to be adopted at a construction site
<b>UCE892: Capstone Project</b>
Inculcate the spirit of teamwork while synthesizing all aspects of problem including technology and
Develop oral and writing skills, while preparing for the project report
Procure in depth knowledge of recent advancements in the chosen area of the project.
Develop research skills that will prepare them for further studies
<b>UCE850: Hydro Power Engineering</b>
Analyze various processes involved in the planning and designing of hydropower projects.
Define and describe various types of hydropower plants
Understand various terms associated with running of hydro turbines
Describe components of underground power stations
Design various components of the hydropower systems
<b>UCE849: Air Quality &amp; Control Engineering</b>
Identify, formulate and solve air pollution problems
Demonstrate a detailed knowledge of study the effect of meteorological parameters in the dispersion of air p
Design and evaluate efficiency of various air pollution control devices used for particulate removal
Design, operate and control the devices used for gaseous emission control
Examine the management strategies for air pollution abatement

## **Program- BE in Computer Engineering**

### **Programme Educational Objectives (PEOs):**

The Computer Engineering program at TIET is designed to prepare its graduates for continued learning and successful careers in industry, government, academia and consulting. The PEOs were finalized in the year 2014 and lastly updated in 2017. During the initial phase, the inputs were sought from industry, faculty, alumni and students. Industry representatives provided a direct voice of the employers and a first draft of PEOs was prepared. The department followed it up with a formation of a sub-committee to develop program objectives and PEOs. The committee finalized the second and the third draft of the PEOs and later in 2015 the Department Planning and Policy Committee (DPPC) of the department approved the PEOs. During the development of PEOs all the stakeholders of the department were considered and their direct or indirect feedback was solicited. The stakeholders of the Computer Science and Engineering department include:

- Students registered in the program
- Program faculty
- Program alumni
- Industry and organizations who hire our students

### **Programme Educational Objectives (2017 onwards)**

Our graduates are expected to:

1. Demonstrate technical expertise to provide solutions for challenging problems by applying computer engineering theory and principles.
2. Engage in life-long learning and professional development to adapt to rapidly changing field of computer engineering.
3. Achieve leadership roles in their profession by inculcating professional ethics and code of professional practices.

### Program Outcomes (POs) of BE (Computer Engineering)

POs	Description
PO1	Apply the knowledge of statistical and mathematical fundamentals, along with computer engineering principles and practices to the solution of complex engineering problems.
PO2	Identify, formulate, review, and analyze complex engineering problems to reach substantiated conclusions using domain knowledge of computer engineering.
PO3	Design system components and processes that meet the quality criteria with appropriate consideration for the cultural, societal and environmental considerations.
PO4	Use research-based knowledge and methods including design of experiments, analysis and interpretation of data to provide valid conclusions.
PO5	Apply appropriate techniques, resources, and computer engineering tools to various engineering activities with an understanding of the limitations.
PO6	Apply contextual knowledge to assess societal, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Understand the impact of the computer engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communicate effectively with engineering community and society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Demonstrate knowledge and understanding of the computer engineering and management principles to manage projects in multidisciplinary environments.
PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

## **Program- ME in Software Engineering**

### **Programme Educational Objectives**

Our Postgraduates in Software Engineering are expected to:

1. Demonstrate the technical knowledge for the development of software related products by adopting the software engineering principles.
2. Achieve leadership roles in their profession by inculcating professional ethics and code of professional practices.

Engage in the life- long learning process and contribute significantly towards research in developing the software products that aid in solving the societal problem.

### **Program Outcomes POs of ME(SE)**

<b>POs</b>	<b>Description</b>
PO1	Ability to apply the principles and methods of Software Engineering in order to design ,develop and validate the Software products
PO2	Ability to analyze, design and test complex Software Engineering problems to reach the substantiated conclusions in the form of Software Products by using the domain knowledge of Software Engineering.
PO3	Design of the reusable Software Components that meet the Quality Standards such as ISO and CMM standards for the cultural, societal, and environmental considerations.
PO4	Ability to apply appropriate research-based knowledge and software engineering methods that aid to analyze, design and test the experimental data through appropriate test case generation .
PO5	Apply the usage of optimization, probability, statistics and simulation tools in fundamental applications along with IT-industry related problem to understand the limitations between academics and industrial research.
PO6	Ability to possess knowledge and understanding of group dynamics, identify opportunities and contribute positively to collaborative-multidisciplinary scientific research.
PO7	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Software Engineering practice.
PO8	Ability to employ in life-long learning through the involvement in contemporary research and to make novel contributions with a high level of passion and promise to improve knowledge.

PO9	Function effectively as an individual, and as a member or leader in diverse Software development teams, and in multidisciplinary settings.
PO10	Communicate effectively with Engineering community and society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Demonstrate knowledge and apply the Software Project Management principles to manage projects in multidisciplinary environments for the delivery of software product
PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## **Program- ME in Computer Science and Engineering**

### **Program Educational Objectives**

Our Postgraduates in Computer Science and Engineering are expected to:

1. Demonstrate technical expertise to provide solutions for challenging problems by applying advanced computer engineering theory and principles.
2. Engage in life-long learning, research and development to adapt updated technologies of computer science and engineering.
3. Achieve leadership roles in their profession by inculcating professional ethics and code of professional practices.

### **Program Outcomes (POs) of ME(CSE)**

PO	DESCRIPTIONS
PO1	Ability to distinguish, analyze, evaluate and amalgamate existing knowledge for enhancement in Computer Science and Engineering.
PO2	Ability to Identify, formulate and analyze complex engineering problems in the context in Computer Science and Engineering.
PO3	Design software system components and processes that meet the quality criteria with appropriate consideration for the cultural, societal, and environmental considerations.
PO4	Ability to develop appropriate research-based knowledge and methods including design of experiments, analysis and interpretation of data individually or in groups and apply it to Computer Science problem.
PO5	Usage of optimization, probability, statistics and simulation tools in fundamental applications along with IT-industry related problem to understand the limitations between



	academics and industrial research.
PO6	Understand group dynamics to identify opportunities and to contribute positively in multidisciplinary scientific research.
PO7	Apply ethical principle to professional responsibilities and norms of the engineering practice.
PO8	Inculcate life-long learning to make novel contributions with a high level of passion and promise to improve knowledge.
PO9	Demonstrate a capacity for self-management and decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals.
PO10	Communicate effectively with engineering community and society to comprehend and write effective reports and design documentation, make effective presentations.
PO11	Demonstrate knowledge and understanding of the computer science engineering and management principles to manage projects in multidisciplinary environments.
PO12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The PEOs and POs of all the programs (UG program in Computer Engineering, ME(SE) and ME(CSE)) of the department of Computer Science & Engineering are published on the home page of the department's link on the website.

The PEOs and POs are published at:

- a) Department website: <http://www.thapar.edu/academics/departments/computer-science-engineering>
- b) Department notice boards

Additionally, the dissemination of PEOs, POs and CLOs to all the stakeholders of the programme is done through student awareness programmes, student induction programmes and faculty meetings. CLOs are also disseminated by each course instructor during introductory sessions in classes, in subject course files and course website, if any.

## **COURSE LEARNING OUTCOMES OF BE (COMPUTER ENGINEERING)**

### **UTA003      COMPUTER PROGRAMMING**

After the completion of the course the student will be able to:

- Learn the implementation of simple 'C' program, data types and operators and Console I/O function.
- Learn the Implementation of decision control statements, loop control statements and case control structures.
- Understand the declaration and implementation of arrays, pointers and functions.
- Understand the file operations, Character I/O, String I/O, File pointers and importance of pre-processor directives.

### **UDP003      INTRODUCTION TO COMPUTER ENGINEERING**

After the completion of the course the student will be able to:

- Understand the concepts related to social context, context aware computing.
- Understand ethical issues and responsibilities related to software development along with the knowledge of other professional ethics.
- Understand the concepts related to intellectual property, legal concepts and professional communication.
- Understand ways to be a sustainable practitioner.
- Understand ethical and legal issues related to security and computer crimes.

### **UTA005      INTERNET AND JAVA PROGRAMMING**

After the completion of the course the student will be able to:

- Understand the basics of Internet, E-mail and allied Services.
- Learn the implementation of decision statement and looping statements.
- Understand concepts of Object Oriented Programming in Java.
- Understand Input and output handling from console, files and internet in Java.
- Learn creation of frames, windows, containers, GUI components in Java and event handling for building GUI.

## **UTA006      WEB DESIGNING**

After the completion of the course the student will be able to:

- Understand the major protocols for internetworking.
- Understand client-server architecture.
- Design basic website.
- Write the basic client-side programming.
- Create HTML documents and use XML tools with different XML technologies to generate XML documents.

## **UCS304      INFORMATION MANAGEMENT SYSTEM**

After the completion of the course the student will be able to:

- Analyze the Information Systems as socio-technical systems, its need and advantages as compared to traditional file-based systems.
- Comprehend architecture of DBMS, conceptual data modeling, logical database design and physical database design.
- Analyze and design database using E-R data model by identifying entities, attributes and relationships.
- Apply and create Relational Database Design process with Normalization and De-normalization of data.
- Demonstrate use of SQL and PL/SQL to implementation database applications.

## **UCS305      PROGRAMMING LANGUAGES CONCEPTS**

After the completion of the course the student will be able to:

- Differentiate between various programming language paradigms and apply object oriented encapsulation mechanisms such as interfaces, private members etc.
- Identify basic algorithms to avoid assigning mutable state, while considering reference equality.
- Develop model-view-controller design view for usage in event handlers in reactive systems such as GUIs.
- Define a new language by applying formal semantics and building a formal model for it.
- Derive expressions of code to demonstrate the difference in the results, when evaluation order is modified.

## **UCS405      DISCRETE MATHEMATICAL STRUCTURES**

After the completion of the course the student will be able to:

- Perform operations on various discrete structures such as set, function and relation.
- Apply basic concepts of asymptotic notation in analysis of algorithm.
- Illustrate the basic properties and algorithms of graphs and apply them in modeling and solving real-world problems.
- Comprehend formal logical arguments and translate statements from a natural language into its symbolic structures in logic.
- Identify and prove various properties of rings, fields and group.

## **UCS406      DATA STRUCTURES AND ALGORITHMS**

After the completion of the course the student will be able to:

- Implement the basic data structures and solve problems using fundamental algorithms.
- Implement various search and sorting techniques.
- Analyze the complexity of algorithms, to provide justification for that selection, and to implement the algorithm in a particular context.
- Analyze, evaluate and choose appropriate data structure and algorithmic technique to solve real-world problems.

## **UCS506      BIG DATA ANALYTICS AND BUSINESS INTELLIGENCE**

After the completion of the course the student will be able to:

- Gain understanding regarding the state of art procedures, standards and techniques applied for data analysis.
- Employ Big Data analysis techniques in present world.
- Understand the Hadoop Ecosystem and apply it to generate datasets for data science and big data analytics project usage.
- Facilitate the application and implementation of Big Data technology for Business process change.
- Exercise Big Data analytics on large datasets to solve statistical and mathematical problems

## **UCS518      COMPUTER NETWORKS**

After the completion of the course the student will be able to:

- Get familiar with computer network architecture (set layer of protocol).
- Design networks by learning simulations tools of network.
- Demonstrate the operation of various routing protocols and their performance analysis.
- Illustrate design and implementation of datalink, transport and network layer protocols within a simulated/real networking environment.
- Get familiar with contemporary issues in networking technology.

## **UCS503      SOFTWARE ENGINEERING**

After the completion of the course the student will be able to:

- Analyze software development process models, including agile models and traditional models like waterfall.
- Demonstrate the use of software life cycle through requirements gathering, choice of process model and design model.
- Apply and use various UML models for software analysis, design and testing.
- Acquire knowledge about the concepts of application of formal specification, case tools and configuration management for software development.
- Analysis of software estimation techniques for creating project baselines.

## **UCS303      OPERATING SYSTEMS**

After the completion of the course the student will be able to:

- Explain basic operating system concepts such as overall architecture, interrupts, APIs, user mode and kernel mode.
- Demonstrate of the concepts related to concurrency including, synchronization primitives, race conditions, critical sections and multi-threading.
- Analyze and apply CPU scheduling algorithms, deadlock detection and prevention algorithms.
- Comprehend various memory management techniques like caching, paging, segmentation, virtual memory, and thrashing.
- Understand operating systems concepts such as file systems, security, protection, virtualization and device-management, disk-scheduling algorithms and various file systems.

## **UCS507      COMPUTER ARCHITECTURE AND ORGANIZATION**

After the completion of the course the student will be able to:

- Comprehend basics of digital electronics such as Flip flops, Registers, Counters, Multiplexer, Demultiplexer, Decoder, Encoder etc.
- Comprehend basic concepts of computer architecture including, syntax of register transfer language, micro-operations, instruction cycle, and control unit.
- Design and analyze the instruction format & addressing modes for a given operation and algorithms for addition, subtraction, multiplication & division.
- Comprehend and study various memory management techniques and furthermore grasp interfacing of computer with input and output devices.
- Comprehend the concept of pipelining, multiprocessors, and inter processor communication and hence evaluation of different contemporary advanced architectures

## **UCS508      GRAPHICS AND VISUAL COMPUTING**

After the completion of the course the student will be able to:

- Comprehend the concepts related to basics of computer graphics and visualization.
- Understand various graphics primitives and 2-D, 3-D geometric transformations
- Understand various clipping techniques.
- Grasp the concepts related three-dimensional object representations.
- Illustrate various hidden surface removal techniques.
- Apply OpenGL to create interactive computer graphics applications.

## **UCS614      EMBEDDED SYSTEMS DESIGN**

After the completion of the course the student will be able to:

- Identify the need and usage of Embedded System.
- Compare and contrast a Real Time Embedded System from other systems.
- Describe the kind of memory and processor.
- Identify and define Bus, Wires and Ports, Basic Protocols of data transfer, Bus arbitration, ISA bus signals, and handshaking, Memory mapped I/O and simple I/O, Parallel I/O and Port Based I/O, examples of interfacing memory to the ports of 8051.
- Discuss field programmable gate array (FPGA) and its application.
- Outline the concept of Internet of Things.

## **UCS615 IMAGE PROCESSING**

After the completion of the course the student will be able to:

- Comprehend the need and usage of concepts of image processing.
- Enhance the visual quality of given grey/color image using well known transformations and filters.
- Distinguish between lossy and lossless image compression prototypes.
- Segment the regions of given image using various feature extraction algorithms in order to recognize object.
- Demonstrate the use of MATLAB to create correlative image processing applications.

## **UCS616 ADVANCED DATA STRUCTURES AND ALGORITHMS**

After the completion of the course the student will be able to:

- Implement the different tree structures algorithm and analyze in context of asymptotic notation.
- Identify basic properties of graphs and apply their algorithms to solve real life problems.
- Demonstrate the usage of algorithms under several categories like string matching, randomized algorithms and genetic algorithms.
- Implement various advanced data structures using C/Java/Python or related languages.

## **UCS631 GPU COMPUTING**

After the completion of the course the student will be able to:

- Comprehend commonly used terms in parallel computing.
- Understand common GPU architectures and Programming Models.
- Implement algorithms efficiently for common application kernels.
- Develop efficient parallel algorithms to solve given problems.

## **UCS632 3D MODELLING & ANIMATION**

After the completion of the course the student will be able to:

- Describe Computer-based Animation using 3D Modeling tool(Blender/Max).

- Develop the practical skills in 2D Splines, Shapes & compound objects.
- Illustrate the theoretical and practical aspects of 3D Modelling, Key Frame Animation, Simulation & effects.
- Demonstrate different types of animation and its effects in the real world.
- Analyze the different processes, post processes involved in computer animation field.

### **UCS633 DATA ANALYTICS AND VISUALIZATION**

After the completion of the course the student will be able to:

- Analyze and extract features of complex datasets.
- Evaluate and visualize inter-dependencies among variables in dataset.
- Apply techniques for classification and clustering in datasets.
- Develop and validate models for real life datasets.

### **UCS634 SECURE CODING**

After the completion of the course the student will be able to:

- Implement ARP poisoning attack and demonstrate countermeasure against these for different operating environments.
- Implement DNS poisoning attack and demonstrate authoritative reply in this context.
- implement PE Code injection and demonstrate control hijacking via EIP manipulation
- Demonstrate skills needed to deal with common programming errors and develop secure applications.
- Demonstrate client side attacks and identify nature of threats to software and incorporate secure coding practices throughout the planning and development of software product.
- Demonstrate SQL, XSS attack and suggest countermeasures for the same.

### **USE401 SOFTWARE METRICS AND QUALITY MANAGEMENT**

After the completion of the course the student will be able to:

- Acquire basic knowledge of Software quality models.



- Exemplify Quality measurement and metrics, Quality plan and implementation
- Articulate Quality control and reliability of quality process and Quality management system models
- Articulate Complexity metrics and Customer Satisfaction and International quality standards.
- Control and manage the project and processes, apply configuration management on the basis of collected metrics.

#### **UCS641 CLOUD COMPUTING**

After the completion of the course the student will be able to:

- Explain the basic concepts along with evolution and features of cloud computing.
- Demonstrate the concept of existing cloud paradigms and platforms.
- Classify the issues of cloud computing in various cloud models.
- Apply the knowledge of virtualization through different virtualization technologies.
- Apply the concept of Map reduce framework using SQL and NO SQL databases.

#### **UCS642 AUGMENTED AND VIRTUAL REALITY**

After the completion of the course the student will be able to:

- Analyze the components of AR and VR systems, its current and upcoming trends, types, platforms, and devices.
- Assess and compare technologies in the context of AR and VR systems design.
- Implement various techniques and algorithms used to solve complex computing problems in AR and VR systems.
- Develop interactive augmented reality applications for PC and Mobile based devices using a variety of input devices.
- Demonstrate the knowledge of the research literature in augmented reality for both compositing and interactive applications.

#### **UML602 NATURAL LANGUAGE PROCESSING**

After the completion of the course the student will be able to:

- Comprehend the concept of natural language processing, its challenges and applications.
- Comprehend the concepts of words form using morphology analysis.

- Acquire the knowledge of syntax and semantics related to natural languages.
- Ability to design and analyze various NLP algorithms.
- Acquire knowledge of machine learning techniques used in NLP.

### **UCS643      CYBER FORENSICS**

After the completion of the course the student will be able to:

- Familiarize with cyber-crime & forensics ontology
- Analyze and demonstrate the crime scene and criminology.
- Redesign the crime scene using digital investigation process
- Recovery of evidence and creating document for judicial proceedings.

### **UML602      NATURAL LANGUAGE PROCESSING**

After the completion of the course the student will be able to:

- Comprehend the concept of natural language processing, its challenges and applications.
- Comprehend the concepts of words form using morphology analysis.
- Acquire the knowledge of syntax and semantics related to natural languages.
- Ability to design and analyze various NLP algorithms.
- Acquire knowledge of machine learning techniques used in NLP.

### **UCS644      SOFTWARE VERIFICATION AND VALIDATION**

After the completion of the course the student will be able to:

- Comprehend the theoretical foundations of testing.
- Comprehend software testing levels, testing techniques and their applicability.
- Generate test cases from software requirements, data flows and finite state machines.
- Perform fault detection using mutants for operators of C and Java language.

### **UCS802      COMPILER CONSTRUCTION**

After the completion of the course the student will be able to:

- Understand in-depth knowledge of working of major phases of compiler.

- Comprehend parser construction using top-down and bottom-up parsing techniques.
- Classify various parameters passing scheme, explain memory management techniques.
- Apply code optimization techniques on HLL.

#### **UCS741 SIMULATION AND MODELLING**

After the completion of the course the student will be able to:

- Describe the role of various elements of discrete event simulation and modeling paradigm.
- Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
- Generate and test random number variates and apply them to develop simulation models.
- Interpret the model and apply the results to resolve critical issues in a real world environment.
- Classify various simulation models and their usage in real-life applications.

#### **UCG731 GAME DESIGN AND DEVELOPMENT**

After the completion of the course the student will be able to:

- Illustrate the basic concepts, requirements, and processes of Game design and development.
- Understand the physics and mathematics behind the game engine.
- Discuss the elements contributing to the design of an advanced 3D game (AI and Networking based game).
- Develop Windows and Android based 3D games using C#.
- Implement some advanced real-world components relevant to games using AR and VR.

#### **UCS742 DEEP LEARNING**

After the completion of the course the student will be able to:

- Comprehend the advancements in learning techniques.
- Compare and explain various deep learning architectures and algorithms.
- Demonstrate the applications of deep learning in various fields.
- Apply deep learning specific open source libraries for solving real life problems.

### **UCS743      ADVANCED COMPUTER NETWORKS**

After the completion of the course the student will be able to:

- Analyze the functionality of network models and working of the network devices.
- Identify various error detection and correction techniques applied in computer networks
- Explore various IEEE standards for wired and wireless networks along with multiple access schemes
- Analyze working of intra and inter domain routing protocols.
- Demonstrate the working of the transport and application layer protocols.

### **UCS709      ADVANCED TOPICS IN SOFTWARE ENGINEERING**

After the completion of the course the student will be able to:

- Comprehend concepts of formal methods and apply mathematical notations for formal specification.
- Evaluate various approaches for software engineering, including cleanroom software engineering and component-based software engineering.
- Demonstrate the use of various tools like CASE and TCS Robot.
- Comprehend web engineering and create web-based application and apply re-engineering concepts on traditional applications.
- Apply software engineering for Mobile Development Process and Embedded Systems

### **UCS703      ARTIFICIAL INTELLIGENCE AND ITS APPLICATIONS**

After the completion of the course the student will be able to:

- Learn the basics and applications of artificial intelligence and categorize various problem domains, basic knowledge representation and reasoning methods.
- Analyze basic and advanced search techniques including game playing, evolutionary search algorithms, and constraint satisfaction.
- Learn and design intelligent agents for concrete computational problems.
- Understand and implement the basic concepts of programming languages like Prolog and LISP.

- Acquire knowledge about the architecture of an expert system and design new expert systems for real life applications.

## **UCS801 SOFTWARE PROJECT MANAGEMENT**

After the completion of the course the student will be able to:

- Describe and apply basic concepts related to software project planning, scope and feasibility.
- Analyze various project estimation techniques.
- Comprehend the concept of team structure and project communication management.
- Acquire knowledge about quality assurance, quality control, and risk management.
- Describe various project management activities such as tracking, project procurement, configuration management, monitoring.

## **UCS806 ETHICAL HACKING**

After the completion of the course the student will be able to:

- Review and summarization of scan, test, hack, and securing own system.
- Apply in depth knowledge and practical experience in current essential security systems.
- Analysis of perimeter defenses work (no real network is harmed).
- Evaluation of intruder mechanism and securing a system.
- Synthesize Intrusion Detection policy, Social Engineering, DDoS attacks, buffer Overflow and Virus Creation.

## **COURSE LEARNING OUTCOMES OF ME (SE)**

### **PSE101 SOFTWARE ENGINEERING CONCEPTS AND METHODOLOGIES**

After the completion of the course the student will be able to:

- Identify the need for engineering approach to software development and various processes of requirements analysis for software engineering problems.

- Analyze various software engineering models and apply methods for design and development of software projects.
- Work with various techniques, metrics and strategies for testing software projects.
- Apply the principles, processes and main knowledge areas for Software Project Management.
- Use standards, CASE tools and techniques for engineering software projects.

### **PSE 102 SOFTWARE DESIGN AND CONSTRUCTION**

After the completion of the course the student will be able to:

- Specify various elements of object modelling to identify, analyze, visualize, specify, model and design
- Apply analysis and design principles at various levels and various views in different domains of software systems.
- Represent engineering problems graphically by drawing all UML diagrams.
- Identify and apply concepts of software construction like Object Oriented Programming skills
- Use Rational Rose tool for drawing all the UML diagrams in order to forward and reverse engineer the complex software engineering problems.

### **PSE 103 SOFTWARE ARCHITECTURE**

After the completion of the course the student will be able to:

- Comprehend the Architecture Business Cycle, Architecture Patterns, Reference Model
- Evaluate and differentiate between various architecture styles
- Familiarize and gain knowledge of various software qualities
- Design, document and reconstructing software architecture

### **PSE104 SOFTWARE PROJECT MANAGEMENT**

After the completion of the course the student will be able to:

- Apply the basic concepts of software project management in order to manage and deliver qualified product.
- Identify and specify the problem with proper documentation to be used in different software teams and organization.

- Work on Technical as well as Cost Benefit Analysis in order to plan the activities within time schedules with CPM and PERT Analysis
- Design Communication Plans, Procurement of Resources and Human Resource Management.

#### **PCS104      ADVANCED DATA STRUCTURES AND ALGORITHMS**

After the completion of the course the student will be able to:

- Understand data structures, needs, basic types of data structures, selection the data structures at assessment level
- Assess the concepts of types of advanced data structures, Internal and External Sorting algorithms
- Assess the concepts of Graph algorithms: Representation, type of Graphs, Paths and Circuits and traversal
- Assess the concept of String Matching Algorithms, implement the different Approximation algorithms, Randomized and Online algorithms

#### **PSE201      SOFTWARE QUALITY MANAGEMENT**

After the completion of the course the student will be able to:

- Acquire basic knowledge of Software quality models
- Understand quality measurement and metrics, quality plan, its implementation and documentation.
- Understand quality tools including CASE tools
- Understand and know quality control and reliability of quality process and Quality management system models
- Understand complexity metrics and customer satisfaction and international quality standards – ISO, CMM.

#### **PSE 202      SOFTWARE VERIFICATION AND VALIDATION TESTING**

After the completion of the course the student will be able to:

- Comprehend the concepts related to theoretical foundations of testing and debugging
- Demonstrate software verification and validation approaches and their applicability

- Formulate and generate test cases from specifications
- Exemplify program mutation testing

### **PSE203 SOFTWARE METRICS**

After the completion of the course the student will be able to:

- Understand the basics of Software Measurement, its underlying objectivity using the quantifiable approach in order to control, manage and Improve quality.
- Apply appropriate software measurement scales according to the characteristic of the projects.
- Control and manage the project and processes, apply configuration management on the basis of collected metrics
- Design and conduct surveys, case studies and experimentation. And also analyse the collected data and draw conclusions and appropriate results graphically.
- Define, design or redesign new direct or indirect metrics

### **PSE 204 ADVANCED TOPICS IN SOFTWARE ENGINEERING**

After the completion of the course the student will be able to:

- Acquire knowledge on the wider perspective of software engineering and architecture issues
- Implement the mathematical notation of the software systems through formal methods.
- Design and construct the software systems using reusable software “components” by acquiring the knowledge about domain engineering and component based development
- Merge the conventional principles, concepts and methods in software engineering with the elements of object oriented and CBSE to create client/server systems.
- Create high quality web applications by using software engineering concepts and principles like formulation, planning, analysis testing and evaluation.

### **PSE205 SOFTWARE METRICS AND QUALITY MANAGEMENT**

After the completion of the course the student will be able to:

- Acquire basic knowledge of Software quality models



- Exemplify quality measurement and metrics, Quality plan and implementation
- Articulate quality control and reliability of quality process and Quality management system models
- Articulate Complexity metrics and Customer Satisfaction and International quality standards – ISO, CMM
- Control and Manage the project and processes, apply configuration management on the basis of collected metrics

## **PSE206      AGILE SOFTWARE DEVELOPMENT**

After the completion of the course the student will be able to:

- Analyze existing problems with the team, development process and wider organization
- Apply a thorough understanding of agile principles and specific practices.
- Select the most appropriate way to improve results for a specific circumstance or need
- Evaluate and craft appropriate adaptations to existing practices or processes depending upon analysis of typical problems
- Evaluate likely successes and formulate plans to manage likely risks or problems

## **PSE 208      SERVICE OIARENTED ARCHITECTURE**

After the completion of the course the student will be able to

- Analyze functions of Service Oriented Architecture and identify the ways in which they can benefit organizations and study the comparison of web services with other technologies
- Evaluate the design of SOA, Major components of the architecture SOAP, XML, HTTP, Cookies, WSDL, XML schema, UDDI and Interactions between various components.
- Learn some of Semantic Web technologies and applications with knowledge of XML's, Grammar rules, namespace schema.
- Create web services and web services clients with state-of-the-art tools .
- Exemplify the web service interoperability, security, and future of web services with the implementation of cloud computing

## **PSE207      COMPONENT BASED DEVELOPMENT**

After the completion of the course the student will be able to:

- Learn and comprehend basic concepts of component based systems, their purpose and scope.
- Analyze software engineering practices related to component based development.
- Apply design of software component infrastructures
- Identify and compare component based development with other development methodologies.
- Relate the concept of legal and regulatory framework.

## **PSE391      SEMINAR**

After the completion of the course the student will be able to:

- Identify domain specific scholarly topic.
- Investigate and tabulate details and history of the selected topic.
- Apply the selected topic in domain or real life.
- Write the technical report effectively.

## **PSE392      CAPSTONE PROJECT**

After the completion of the course the student will be able to:

- Investigate and identify real world problems
- Design , develop and implement a domain specific project
- Apply advanced programming techniques in the project
- Write the technical report effectively.

## **COURSE LEARNING OUTCOMES OF ME (CSE)**

### **PCS 103      ADVANCED ARTIFICIAL INTELLIGENCE**

After the completion of this course the student will able to:

- Comprehend the applications of artificial intelligence and categorize various problem domains, uninformed and informed search methods.
- Explore and implement advanced search techniques and algorithms like minimax for game playing.
- Illustrate the importance of probability in knowledge representation for reasoning under uncertainty.
- Express the knowledge using Bayesian networks and Hidden Markov Models.
- Discuss the architecture for expert system and intelligent agent and implement an intelligent agent/expert system

### **PCS104      ADVANCED DATA STRUCTURES AND ALGORITHMS**

After the completion of this course the student will able to:

:

- Implement the basic data structures, advanced data structures, Internal and External Sorting algorithms and learn the appropriate algorithmic approach to a problem.
- Demonstrate the ability to evaluate algorithms, to provide justification for that selection, and to implement the algorithm in a particular context
- Employ graphs to model a variety of real-world problems, synthesize tree and graph algorithms and analyze them.
- Implement advance algorithmic techniques such as String Matching Algorithms, Approximation algorithms etc.

### **PCS 105      ADVANCED OPERATING SYSTEM**

After the completion of this course the student will able to:

- Get familiar with the basics of advanced operating systems, concurrency, and various deadlock models.

- Comprehend the primitives of distributed operating systems with issues pertaining related to the deadlock detection.
- Explore the diverse protocols available for the resource management and, fault recovery and tolerance in the distributed system.
- Proverbial with the primitives and algorithms available for managing the database operating systems.

## **PCS106      PARALLEL AND DISTRIBUTED COMPUTING**

After the completion of this course the student will able to:

- Learn the concepts, issues and tasks in parallel and distributed computing along with different parallel architectures
- Demonstrate the principles for Parallel Algorithm Design.
- Explore the parallel programming models and algorithms for common operations.
- Analyze the application of parallel algorithms to solve the complex computational problems.
- Implement various parallel algorithms with CUDA.

## **PCL105      STATISTICAL METHODS AND ALGORITHMS**

After the completion of this course the student will able to:

- Understand concepts of probability distributions and statistical data analysis techniques.
- Recognize the properties and characteristics of Markov Chain Model
- Understand data classification techniques using fixed effect and random effect models.
- Understand and analyze time series data.

## **PCS204      ADVANCED INFORMATION MANAGEMENT SYSTEMS**

After the completion of this course the student will able to:

- Comprehend techniques of Transaction Processing, Concurrency Control and Database Recovery Technique.
- Design distributed database and apply concurrency control and recovery of data on distributed database.
- Comprehend the concept of Object-Oriented DBMS and NoSQL data models.
- Explain the need of Data Warehousing Concepts, OLAP and Data mining.
- Demonstrate use of PL/SQL to develop database centric applications.

### **PCS 205      BIG DATA ANALYTICS AND BUSINESS INTELLIGENCE**

After the completion of this course the student will able to:

- Comprehend the concepts of big data, architecture and environment, digital data types, structure and its implementation.
- Explore the advanced level of understanding of the usage of Big Data in present World.
- Understand the concepts of Map-Reduce, HDFS command and Hadoop services and its implementation.
- Use software tools such as R and Hadoop, in text analytics.

### **PCS 206      MACHINE LEARNING**

After the completion of this course the student will able to:

- Demonstrate in-depth knowledge of methods and theories in the field of machine learning.
- Demonstrate the use Bayesian perspective on machine learning, artificial neural networks, back propagation algorithm.
- Assess the learning algorithms modeled after biological evolution, including genetic algorithms and genetic programming.
- Demonstrate the ability to critically evaluate and compare different learning models and learning algorithms.
- Design new algorithms after combining some of the key elements of existing machine learning algorithms.

### **PCS207      SOFTWARE ENGINEERING AND PROJECT MANAGEMENT**

After the completion of this course the student will able to :

- Comprehend the need for engineering approach to software development. To understand various processes of requirements analysis for software engineering problems.
- Assess the various concepts of software engineering models and apply methods for Design and Development of software projects.
- Appreciate and apply various techniques, metrics and strategies for testing software projects.
- Comprehend the principles, processes and main knowledge areas for Software Project Management including Software Quality Management, Risk Management and Software Configuration Management.
- Apply the standards, CASE tools and techniques for engineering software projects efficient ways.

#### **PIS 215      MOBILE APPLICATION SECURITY**

After the completion of this course the student will able to:

- Acquire knowledge in developing mobile applications with an awareness of the security issues involved in them.
- Identify Android Security Model and Development environment.
- Demonstrate knowledge of Windows mobile development platform, kernel architecture, development and security testing.
- Tabulate Symbian OS devices, their development and security testing.
- Recollect iPhone Security Model and Development environment

#### **PCS213      DATA MINING AND KNOWLEDGE MANAGEMENT**

After the completion of this course the student will able to perform:

- Comprehend the need of big data and to access current state of practices used for data analytics.
- Comprehend and demonstrate association mining techniques for market basket analysis.
- Perform classification of data by using decision tree, split algorithm based on information theory, Gini index and Naïve Bayes.

- Demonstrate clustering of data by using partitioned methods, hierarchical methods and density based methods.
- Comprehend the techniques and use of web data mining and search engine.

### **PIS392      CAPSTONE PROJECT**

After the completion of this course the student will able to:

- Investigate and identify real world problems.
- Design, develop and implement a domain specific project.
- Apply different skills learned in the program.
- Technical report writing
- Demonstrating and communicating the working and impact of the project

### **PCA391      SEMINAR**

After the completion of this course the student will able to:

- Identification of a domain specific scholarly topic
- Investigate and tabulate details and history about the selected topic
- Apply the selected topic in the domain or real life
- Write the technical report effectively.
- Demonstrate the communication skills by effective presentation and engagement of the audience.

### **PIS091      THESIS**

After the completion of this course the student will able to:

- Identify, formulate and analyze domain specific scholarly research problems
- Design and implement the identified research problem.
- Write the technical report effectively and Publish the research work in referred journals, National and international conferences of Repute.

Foresee how their current and future work will influence/impact the economy, society and the environment.

# **Department of Electronics and Communication Engineering**



**2.6.1 : Programme outcomes, Programme specific outcomes and course outcomes for all Programmes offered by the institution are stated and displayed on website and communicated to teachers and students**

### **Web Links**

- **PEOs & POs of B.E (ECE):**  
<http://www.thapar.edu/academics/departpages/peos-pos92>
- **PEOs & POs of B.E (ENC):**  
<http://www.thapar.edu/academics/departpages/peos-pos93>
- **Course Outcomes of B.E (ECE and ENC):**  
<http://www.thapar.edu/academics/departpages/course-outcomes92>
- **PEOs & POs of M.E (ECE):**  
<http://www.thapar.edu/academics/departpages/peos94>
- **PEOs & POs of M.Tech (VLSI Design):**  
<http://www.thapar.edu/academics/departpages/peos-pos95>
- **Course Outcomes of M.E (ECE):**  
[http://www.thapar.edu/upload/files/Course\\_Outcome\\_M.E\\_ECE.pdf](http://www.thapar.edu/upload/files/Course_Outcome_M.E_ECE.pdf)
- **Course Outcomes of M.Tech (VLSI Design):**  
[http://www.thapar.edu/upload/files/Course\\_Outcome\\_M.Tech\\_VLSI\\_Design.pdf](http://www.thapar.edu/upload/files/Course_Outcome_M.Tech_VLSI_Design.pdf)

#### **PEOs of B.E (ECE)**

The Electronics and Communication Engineering Program at Thapar Institute of Engineering & Technology is aimed to prepare its graduates for continued learning and successful careers in design, application, installation, operation and/or maintenance of electronic(s) systems. Our graduates are expected to:

1. Excel in professional engineering practice by applying their engineering knowledge and problem solving skills.
2. Continue their intellectual development imbibing ability for lifelong learning by pursuing higher education or professional development courses.
3. Attain leadership roles in their careers as ethical and responsible professionals and innovate continuously for societal improvement

#### **POs of B.E (ECE)& B.E (ENC)**

The students of undergraduate program in Electronics and Communication Engineering will have

- A. an ability to apply knowledge of mathematics, science, and engineering.
  - A1. Applying mathematics (calculus, differential equations, linear algebra, transforms etc.) to obtain analytical and numerical solutions.
  - A2. Demonstrate knowledge of fundamentals, scientific and/or engineering principles.
  - A3. Applying scientific and/or engineering principles towards solving engineering problems.
  - A4. Applying statistical methods in analyzing data.
  
- B. an ability to design and conduct experiments, as well as to analyze and interpret data.
  - B1. Identifying the constraints, assumptions and models for the experiments -
  - B2. Use appropriate equipment and techniques for data collection.
  - B3. Analyze experimental data using appropriate tools and/or statistical tools.
  - B4. Validate experimental results with respect to assumptions, constraints and theory.
  
- C. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
  - C1. Analyze needs to produce problem definition for electronics and communication systems.
  - C2. Carries out design process to satisfy project requirement for electronics and communication systems
  - C3. Can work within realistic constraints in realizing systems.
  - C4. Can build prototypes that meet design specifications.
  
- D. an ability to function on multidisciplinary teams.
  - D1. Shares responsibility and information schedule with others in team
  - D2. Participates in the development and selection of ideas.
  
- E. an ability to identify, formulate, and solve engineering problems.
  - E1. Classifies information to identify engineering problems.
  - E2. Develop appropriate models to formulate solutions.
  - E3. Uses analytical, computational and/or experimental methods to obtain solutions.
  
- F. an understanding of professional and ethical responsibility.
  - F1. Evaluates ethical issues that may occur in professional practice using professional codes of ethics.
  - F2. Interacts with industry, project sponsors, professional societies and/or communities in a professional manner.
  
- G. an ability to communicate effectively.
  - G1. Produce a variety of documents such as laboratory or project reports using appropriate formats and grammar with discipline specific conventions including citations.
  - G2. Deliver well organized, logical oral presentation, including good explanations when questioned.
  
- H. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
  - H1. Aware of societal and global changes that engineering innovations may cause.
  - H2. Examines economics tradeoffs in engineering systems.
  - H3. Evaluates engineering solutions that consider environmental factors.
  
- I. a recognition of the need for, and an ability to engage in life-long learning.
  - I1. Able to use resources to learn new devices and systems, not taught in class.
  - I2. Ability to list sources for continuing education opportunities.
  - I3. Recognizes the need to accept personal responsibility for learning and of the importance of life long learning.
  
- J. a knowledge of contemporary issues.
  - J1. Describes the importance of contemporary issues.
  - J2. Describes the impact of engineering decisions on energy resources/environment.

- K. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
  - K1. Able to operate engineering equipments
  - K2. Able to program engineering devices.
  - K3. Able to use electronic devices, circuits and systems modeling softwares for engineering applications.
  - K4. Able to analyze engineering problems using software tools.

#### **PEOs of B.E (ENC)**

1. Excel in professional career and/or higher education by acquiring knowledge in mathematical, scientific and engineering principles.
2. Analyse real life problems, design novel electronic/computer products and systems that are technically sound, economically feasible and socially acceptable.
3. Inculcate professionalism, ethical attitude, effective communication skills, team work, and multidisciplinary approach in their profession related to electronic and computer engineering, and also adapt to current trends by engaging in learning.

#### **PEOs of M.E (ECE)**

- **PEO1:-** Ability to have successful careers in Electronics and Communication Engineering as well as associated emerging fields pertaining to the modern technology; and graduating students will be able to work with inter-disciplinary groups in professional, industrial and research organizations.
  - **PEO 1.1.** Progress in professional career
  - **PEO 1.2.** Higher education
  - **PEO 1.3.** Professional conduct and interpersonal skills
- **PEO2:-** Ability to develop capabilities in experimental /theoretical/simulation based research methods, analysis of data, and drawing relevant conclusions for the scholarly writing and presentation.
  - **PEO 2.1.** Capability of doing research
  - **PEO 2.2.** Design and develop economically feasible solutions
  - **PEO 2.3.** Communicating the research outputs

#### **POs of M.E (ECE)**

POs describe what students are expected to know or be able to do by the time of graduation from the programme. After the completion of course work, the students of M.E. (Electronics and Communication Engineering) will be able

- to review, document and effectively communicate the knowledge as well as research developed by them and/or scholarly predecessors
- to design and conduct experiments, and/or analyze and interpret data
- to identify, formulate and solve engineering as well as technological problems
- to function in the multidisciplinary teams
- to understand the impact of engineering solutions in a global and societal context
- to recognize the need for life-long learning
- to use the techniques, skills and modern Electronics and Communication Engineering related design tools necessary for the engineering practice
- to analyze and design Electronics and Communication systems containing hardware as well as software components

### PEOs of M.Tech (VLSI Design)

- **PEOs 1.**To facilitate and educate the students to equip themselves with the state-of-the-art tools and technology for the fast changing world of technology
- **PEOs 2.**To guide and mould the next generation of engineers to face any multidisciplinary engineering challenges ahead in academia and industry with economic, environmental and social contexts.
- **PEOs 3.**To provide a well-rounded education that includes communication skills, the ability to function well on a team, an appreciation for ethical behavior, and the ability to engage in lifelong learning

### POs of M.Tech (VLSI Design)

The Post Graduates of M. Tech. (VLSI Design) will be able to:

- Demonstrate the knowledge of mathematics, science and engineering.
- Identify, formulate and solve engineering problems reaching substantiated conclusions.
- Communicate effectively on engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- Conduct investigations of related problems including design and conduct of experiments, analysis and interpretation of data.
- Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
- Design a system, component or process as per societal needs and specifications and also will be aware of contemporary issues.
- Realize the need for self-education and ability for independent and life-long learning.
- Use the techniques, skills and modern engineering tools necessary for engineering practice.
- Understand and commit to professional ethics and responsibilities and norms of engineering practice.

### COURSE OUTCOMES OF B.E. ELECTRONICS

Course	Course Outcome
<b>UES007- Semiconductor Devices</b>	CO1: To acquire knowledge about semiconductor physics for intrinsic and extrinsic materials. CO2: To learn the basics of semiconductor diodes, BJTs and their small signal and high frequency analysis. CO3: To study and analyze the performance of FETs on the basis of their operation and working. CO4: To study and analyze the rectifier and regulated circuits.
<b>UEC302- Digital Electronic Circuits</b>	CO1: Acquired knowledge about basics of digital electronics. CO2: Acquired knowledge about solving problems related to number systems and Boolean algebra. CO3: Ability to identify, analyze and design combinational circuits. CO4: Ability to design various synchronous and asynchronous sequential circuits. CO5: Acquired knowledge about internal circuitry and logic behind any digital system.

<b>UEC404- Signals and Systems</b>	<p>CO1: Acquired knowledge about continuous &amp; discrete-time signals.</p> <p>CO2: Ability to identify LTI &amp; non-linear time-varying systems.</p> <p>CO3: Foster ability to work using Fourier series &amp; z-transform.</p> <p>CO4: Foster ability to work using Laplace Trans., CTFT and DTFT.</p> <p>CO5: Acquired knowledge about FFT &amp; IFFT.</p> <p>CO6: Ability to identify characteristics of Wide Sense Stationary random processes.</p>
<b>UEC403- Circuit Analysis and Synthesis</b>	<p>CO1: Acquired knowledge about Circuit components and Network graph.</p> <p>CO2: Ability to identify the Network Theorems and Two Port Network Descriptions.</p> <p>CO3: Ability to identify response of Network Functions</p> <p>CO4: Foster ability to work using Time domain systems.</p> <p>CO5: Ability to identify the characteristics of Attenuators and Filters</p> <p>CO6: Acquired knowledge about Network Synthesis.</p>
<b>UEC301- Analog communication system</b>	<p>CO1: Acquired knowledge about analog communication.</p> <p>CO2: Acquired knowledge about AM transmission and reception.</p> <p>CO3: Acquired knowledge about FM and PM transmission and reception.</p> <p>CO4: Acquired knowledge about pulse modulation.</p> <p>CO5: Acquired knowledge about noise.</p>
<b>UEC502- Digital Signal Processing (DSP)</b>	<p>CO1: Acquired knowledge about discrete-time sequences, concept of energy and power, periodicity.</p> <p>CO2: Acquired knowledge DFT and FFT.</p> <p>CO3: Ability to design linear digital filters both FIR and IIR using different techniques and their associated structures.</p> <p>CO4: Ability to understand the concept of linear prediction and estimation.</p> <p>CO5: Ability to understand the concept of Multi-rate signal processing and sample rate conversion.</p> <p>CO6: Acquired knowledge about time-frequency analysis.</p>
<b>UEC403- Analog Electronic Circuits</b>	<p>CO1: To understand the concept of multistage amplifiers, analysis of multistage amplifier and its frequency response, Darlington pair and bootstrap circuits.</p> <p>CO2: To learn the basics of tuned amplifiers such as single tuned, double tuned, stagger tuned &amp; power amplifiers.</p> <p>CO3: To study and analyze the performance of negative as well as positive feedback circuits.</p> <p>CO4: To study and analyze the wave shaping circuits and operational amplifiers.</p>
<b>UEC504- Microprocessors</b>	<p>CO1: Acquired knowledge about Microprocessors and its need.</p> <p>CO2: Ability to identify basic architecture of different Microprocessors.</p>

	<p><b>CO3:</b> Foster ability to write the programming using 8085 microprocessor.</p> <p><b>CO4:</b> Foster ability to understand the internal architecture and interfacing of different peripheral devices with 8085 Microprocessor.</p> <p><b>CO5:</b> Foster ability to write the programming using 8086 microprocessor.</p> <p><b>CO6:</b> Foster ability to understand the internal architecture and interfacing of different peripheral devices with 8086 Microprocessor,</p>
<b>UEC501- Digital communication system</b>	<p><b>CO1:</b> Acquired knowledge about of basics analog and digital communication.</p> <p><b>CO2:</b> Acquired knowledge about , quantization and coding.</p> <p><b>CO3:</b> Acquired knowledge about different M-ary modulation techniques.</p> <p><b>CO4:</b> Acquired knowledge about of inter symbol interference (ISI ).</p> <p><b>CO5:</b> Acquired knowledge different estimation methods.</p>
<b>UEC302- Electromagnetic Field Theory &amp; Transmission Lines</b>	<p><b>CO1:</b> Ability to apply knowledge of mathematics, science, and engineering to the analysis and design of systems involving electric and magnetic fields as well as electromagnetic waves.</p> <p><b>CO2:</b> Ability to identify, formulate, and solve engineering problems in the area of electric and magnetic fields and waves.</p> <p><b>CO3:</b> Ability to use the techniques, and skills, which are necessary for engineering practice.</p> <p><b>CO4:</b> Acquire skills to carry out search for technical issues.</p>
<b>UEC603- Microcontrollers and Embedded Systems</b>	<p><b>CO1:</b> Acquired knowledge about Microcontroller and its need.</p> <p><b>CO2:</b> Ability to identify basic architecture of different Microcontroller 8051.</p> <p><b>CO3:</b> Foster ability to write the programming using 8051 microcontroller.</p> <p><b>CO4:</b> Foster ability to understand the internal architecture and interfacing of different peripheral devices with 8051 Microcontrollers.</p> <p><b>CO5:</b> Foster ability to understand the role of Embedded systems in industry.</p> <p><b>CO6:</b> Foster ability to understand the design concept of Embedded systems,</p>
<b>UEC612- Digital System Design</b>	<p><b>CO1:</b> Acquired knowledge about combinational &amp; sequential circuits.</p> <p><b>CO2:</b> Foster ability to identify and code the module using different modeling styles.</p> <p><b>CO3:</b> Foster ability to code using subprograms.</p> <p><b>CO4:</b> Foster ability to write test benches in VHDL.</p> <p><b>CO5:</b> Acquired knowledge about FSM and how to code a FSM.</p> <p><b>CO6:</b> Ability to synthesize the VHDL code.</p>
<b>UEC601- Antenna theory &amp; Wave Propagation</b>	<p><b>CO1:</b> Identify basic antenna parameters.</p> <p><b>CO2:</b> Design and analyze wire and aperture antennas.</p> <p><b>CO3:</b> Design and analyze antenna arrays.</p> <p><b>CO4:</b> Capable of performing various antenna measurements.</p>

		<b>CO5:</b> Ability to identify characteristics of radio wave propagation.
<b>UEC602- Linear Integrated Circuits(UEC613)</b>		<b>CO1:</b> Understand the terminal characteristics of op-amps and design /analyse fundamental circuits based on op-amps. <b>CO2:</b> Analyse feedback and its effect on the performance of op-amp. <b>CO3:</b> Design and analysis of nonlinear circuits. <b>CO4:</b> Design and analysis of active filters. <b>CO5:</b> Design and analysis of various applications using op-amps and IC 555.
<b>UEC621- CMOS Circuit Design</b>		<b>CO1:</b> Understand the Physics of MOS device. <b>CO2:</b> Understand the CMOS process technology. <b>CO3:</b> Ability to design layout of CMOS circuits. <b>CO4:</b> Understand the characteristics of CMOS circuits. <b>CO5:</b> Ability to understand the basic difference between static and dynamic CMOS logic circuits. <b>CO6:</b> Understand CMOS transmission gates, latches and registers.
<b>UEC604- Modern Control System</b>		<b>CO1:</b> Undertake steady state and transient analysis of a system. <b>CO2:</b> Undertake stability analysis of a system. <b>CO3:</b> Solve closed loop control design problems. <b>CO4:</b> Ability to undertake state space analysis and solve state equations. <b>CO5:</b> Undertake stability analysis of non linear systems.
<b>UEC402- Computer Architecture</b>		<b>CO1:</b> Acquired knowledge about Fundamentals of Computer Design <b>CO2:</b> Ability to identify basic Instruction Set Principles. <b>CO3:</b> Foster ability to understand Pipelining and Parallelism. <b>CO4:</b> Foster ability to understand the concept of Multiprocessors. <b>CO5:</b> Foster ability to understand the Memory Hierarchy Design and its interfacing with microprocessors. <b>CO6:</b> Foster ability to understand the Input/Output Organization and Buses.
<b>UEC612- Data Communi0ation</b>		<b>CO1:</b> To introduce basic concepts of Data communication with different models. <b>CO2:</b> Enumerate the physical layer, DLL , NL, TL and AL, its explanation of the function(s) of each layer. <b>CO3:</b> To introduce about the switching concept and its different types.
<b>UEC801- Advanced Solid State Devices</b>		<b>CO1:</b> Ability to understand the basic operation and working of different diodes like PIN, Varactor diode etc. <b>CO2:</b> To understand the high frequency application of diodes. <b>CO3:</b> To understand and use of the device models to explain and calculate the characteristics of the field effect transistors. <b>CO4:</b> To be able to understand and analyze the V-I characteristics of different high power devices. <b>CO5:</b> Understand the operation of charge-transfer devices and charge storage devices.
<b>UEC802- Fiber Optic Communication</b>		<b>CO1:</b> Fundamentals, advantages and advances in optical communication system.

	<p><b>CO2:</b> Types, basic properties and transmission characteristic of optical fibers.</p> <p><b>CO3:</b> Knowledge of working and analysis of optical amplifiers and important parts at the transmitter (Semiconductor lasers/LEDs, modulators etc) as well as at the receiver sides (optical detector etc.) of the optical communications system.</p> <p><b>CO4:</b> Configuration and architecture of coherent optical communication, advanced system techniques and nonlinear optical effects and their applications.</p>
<b>UEC804- Wireless and Mobile Communication</b>	<p><b>CO1:</b> Knowledge about of technologies used in wireless comm.</p> <p><b>CO2:</b> Knowledge about overall GSM cellular concept.</p> <p><b>CO3:</b> Knowledge about multiple access technologies.</p> <p><b>CO4:</b> Knowledge about the effect of fading and Different fading models.</p> <p><b>CO5:</b> Knowledge different of different spread spectrum techniques.</p> <p><b>CO6:</b> Study different diversity techniques.</p>
<b>UEC505- Microwave Engineering</b>	<p><b>CO1:</b> Knowledge about Microwave Solid State Devices.</p> <p><b>CO2:</b> Ability to identify and study the performance of Wave Guides and Resonators</p> <p><b>CO3:</b> Study the performance of Microwave Components.</p> <p><b>CO4:</b> Study the comparative performance analysis of Microwave Tubes and Circuits.</p> <p><b>CO5:</b> Knowledge about Microwave Measurements.</p> <p><b>CO6:</b> Study the measurement of impedance using smith chart.</p>
<b>UEC851- VLSI Digital Signal Processing</b>	<p><b>CO1:</b> Acquired knowledge about DSP algorithms, its DFG representation, pipelining and parallel processing approaches.</p> <p><b>CO2:</b> Ability to acquire knowledge about retiming techniques, folding and register minimization path problems.</p> <p><b>CO3:</b> Ability to understand the concepts of systolic architecture and its methodology.</p> <p><b>CO4:</b> Ability to have knowledge about algorithmic strength reduction techniques and parallel processing of FIR and IIR digital filters.</p> <p><b>CO5:</b> Acquired knowledge about finite word-length effects and round off noise computation in DSP systems.</p>
<b>UEC803- Radar, Satellite and Navigational Aids</b>	<p><b>CO1:</b> Acquired knowledge about Radar and Radar Equations.</p> <p><b>CO2:</b> Understanding the working principal of MTI and Pulse Doppler Radar.</p> <p><b>CO3:</b> Foster ability to work using Detection of Signals in Noise and Radio Direction Finding.</p> <p><b>CO4:</b> Foster ability to work using Instrument Landing System.</p> <p><b>CO5:</b> Acquired knowledge about Satellite Navigation System.</p>
<b>UEC614- Telecommunication Engineering</b>	<p><b>CO1:</b> Acquired knowledge about Switching Systems.</p> <p><b>CO2:</b> Learn about ISDN.</p> <p><b>CO3:</b> Learn about architecture, signalling and control of EPABX ,ATM etc.</p> <p><b>CO4:</b> Acquired knowledge about</p>



	Traffic Engineering.
<b>UEC715- Switching Circuits and Automata</b>	<p><b>CO1:</b> Acquire knowledge about switching theory and algebra.</p> <p><b>CO2:</b> Ability to learn and design sequential circuits.</p> <p><b>CO3:</b> Acquire knowledge and ability to analyze threshold gates and their synthesis.</p> <p><b>CO4:</b> Foster ability to use PLDs and PLAs.</p> <p><b>CO5:</b> Acquired knowledge about and ability to design ASM and FSM.</p> <p><b>CO6:</b> Learn about various fault tolerance and diagnosis techniques.</p>
<b>UEC622- DSP Processors</b>	<p><b>CO1:</b> Acquired knowledge about Fundamentals of DSP Processors.</p> <p><b>CO2:</b> Ability to understand the DSP Architecture.</p> <p><b>CO3:</b> Foster ability to understand memory architecture for DSP.</p> <p><b>CO4:</b> Foster ability to understand the need of different types of instructions for DSP.</p> <p><b>CO5:</b> Foster ability to understand architecture of different types of DSP processor 8 bit and 16 bit.</p> <p><b>CO6:</b> Foster ability to design and implementation of different applications using DSP on FPGA.</p>
<b>UEC611- Audio and Speech Signal Processing</b>	<p><b>CO1:</b> Acquired knowledge about audio &amp; speech signals.</p> <p><b>CO2:</b> Ability to understand speech generation models.</p> <p><b>CO3:</b> Foster ability to understand speech recognition models.</p> <p><b>CO4:</b> Understanding of audio &amp; speech signal estimation &amp; detection.</p> <p><b>CO5:</b> Acquired knowledge about hardware to process audio &amp; speech signals.</p> <p><b>CO6:</b> Ability to relate human physiology and anatomy with signal processing paradigms.</p>
<b>UEC624- Soft Computing Techniques</b>	<p><b>CO1:</b> Solve Pattern Classification &amp; Function Approximation Problems.</p> <p><b>CO2:</b> Design appropriate ANN model for a given Problem.</p> <p><b>CO3:</b> Knowledge of data pre-processing techniques.</p> <p><b>CO4:</b> Impart ability to build Fuzzy inference systems from linguistic models.</p> <p><b>CO5:</b> Impart knowledge of genetic optimization and ability to create objective functions for a given optimization problem</p>
<b>UEC506- Microelectronics- IC Design and Fab</b>	<p><b>CO1:</b> Acquire knowledge about crystal growth and wafer preparation techniques.</p> <p><b>CO2:</b> Learn about MOSFET fabrication process.</p> <p><b>CO3:</b> Understand various linear and non linear ICs.</p> <p><b>CO4:</b> To understand the various packaging techniques.</p>
<b>UEC701- ASICs and FPGAs</b>	<p><b>CO1:</b> Acquire knowledge about designing and implementation of various combinational &amp; sequential circuits.</p> <p><b>CO2:</b> Introduce digital design techniques using various Programmable logic devices.</p> <p><b>CO3:</b> To introduce FPGA architecture, digital design flow using FPGAs, and other technologies associated with field programmable gate arrays.</p>

		<p><b>CO4:</b> To learn about various applications of FPGAs</p> <p><b>CO5:</b> To get to know about the logic and physical designing of an ASIC.</p>
<b>UEC841- Intelligence</b>	<b>Artificial</b>	<p><b>CO1:</b> Understand the challenges and the usefulness of Artificial Intelligence with design a game playing program.</p> <p><b>CO2:</b> Appreciate the issues involved in knowledge bases, reasoning systems, and planning.</p> <p><b>CO3:</b> Understand the various learning methods and search algorithms.</p> <p><b>CO4:</b> Understand the potential and current research issues in Artificial Intelligence.</p>
<b>UEC742 - MEMS</b>		<p><b>CO1:</b> Introduce basic micromachining/fabrication processes used in MEMS.</p> <p><b>CO2:</b> Analyze and understand the concept related to optical, RF, Magnetic, Electrical and Bio MEMS devices.</p> <p><b>CO3:</b> Acquire the fundamentals knowledge of various types of actuator and solve problem related to various design issues.</p> <p><b>CO4:</b> Study applications of MEMS devices to give a brief idea of MEMS role in Miniaturization.</p>
<b>UEC852- Networks</b>	<b>Wireless Sensor</b>	<p><b>CO1:</b> Ability to understand various physical and wireless MAC layer alternatives.</p> <p><b>CO2:</b> Understanding the integration of voice and data traffic.</p> <p><b>CO3:</b> Ability to understand wireless network planning and operation.</p> <p><b>CO4:</b> Ability to design wireless LAN, WAN, PAN and geolocation systems.</p>
<b>UEC853- Networks</b>	<b>Wireless Adhoc</b>	<p><b>CO1:</b> To introduce the fundamental of wireless communication technology.</p> <p><b>CO2:</b> To introduce and analyze the Adhoc routing protocols.</p> <p><b>CO3:</b> To introduce the various issues in designing a multicast routing protocol.</p> <p><b>CO4:</b> To introduce a transport layer protocol and challenges for providing QOS in Adhoc wireless networks.</p>

## **Course Outcome of M.Tech (VLSI Design)**

### **PVL108: Device Physics and Technology**

The students are able to:

1. Understand the basic physics of semiconductor devices and the basics theory of PN junction.
2. Understand the basic theory of MOS transistors.
3. Understand the basic steps of fabrication.
4. Learn the basics theory of Crystal Growth and Wafer Preparation.
5. Study the Epitaxy, Diffusion, Oxidation, Lithography and Etching.
6. Understand the basic theory of Nano-Fabrication.

### **PVL109: FPGA based System Design**

The student will be able to

1. Model digital systems in VHDL and SystemC at different levels of abstraction.
2. Partition a digital system into different subsystems.
3. Simulate and verify a design.
4. Transfer a design from a version possible to simulate to a version possible to synthesize.
5. Use computer-aided design tools to synthesize, map, place, routing, and download the digital designs on the FPGA board.

### **PVL103: Digital VLSI Design**

The students are able to:

1. Understand the basic Physics and Modelling of MOSFETs.
2. Learn the basics of Fabrication and Layout of CMOS Integrated Circuits.
3. Study and analyze the performance of CMOS Inverter circuits on the basis of their operation and working.
4. Study the Static CMOS Logic Elements.
5. Study the Dynamic Logic Circuit Concepts and CMOS Dynamic Logic Families.

### **PVL110 : VLSI Architectures**

The students will able to:

1. To review the basics of different processors including architecture and organization
2. To foster ability of handling and designing different types of pipelining techniques; exception handling corresponding instruction scheduling.
3. To understand various memory organization and management techniques
4. To Understand the various advanced architectures.
5. To achieve the understanding of parallel, shared architectures and important organizational details of superscaler architecture

### **PVL206: Analog IC Design**

The student will be able to:

1. Apply knowledge of mathematics, science, and engineering to design and analysis of analog integrated circuits.
2. Identify, formulates, and solves engineering problems in the area of analog integrated circuits.

3. Use the techniques, skills, and modern programming tools such as Mentor Graphics, necessary for engineering practice.
4. Participate and function within multi-disciplinary teams.

### **PVL207: Low Power System Design**

The student will be able to:

1. Understand the need for low power in VLSI.
2. Understand various dissipation types in CMOS.
3. Estimate and analyse the power dissipation in VLSI circuits.
4. Understand the probabilistic power techniques.
5. Derive the architecture of low power SRAM circuit.

### **PVL208: VLSI Testing and Verification**

The student will be able to

1. Analyse the use of procedural statements and routines in testbench design with system verilog.
2. Apply OOP concepts in designing testbench with system verilog.
3. Apply randomization concepts in designing testbench.
4. Understand use of multi threading and inter process communication in testbench design.
5. Interface a system verilog testbench with system C.

### **PVL203 VLSI SIGNAL PROCESSING**

1. To learn performance optimization techniques in VLSI signal processing,
2. Transformations for high speed and power reduction using pipelining, retiming, parallel processing techniques, supply voltage reduction as well as for strength or capacitance reduction,
3. Area reduction using folding techniques, Strategies for arithmetic implementation,
4. Synchronous, wave, and asynchronous pipelining

### **PVL: Nanoelectronics**

The student will be able to

1. Acquire knowledge about nanoelectronics and shrink down approach.
2. Understand concept behind nanomofets and nano devices.
3. Set up and solve the Schrodinger equation for different types of potentials in one dimension as well as in 2 or 3 dimensions for specific cases.
4. Understand the nanofabrication and characterization facilities.

### **PVL: VLSI Interconnects**

The student will be able to

1. Acquire knowledge about Technology trends, Device and interconnect scaling.
2. Identify basic device and Interconnect Models.
3. Perform RLC based Interconnect analysis.
4. Understand the Problem with existing material in deep submicron.
5. Understand the advanced interconnect materials

### **PVL216: VLSI Subsystem Design**

The student will be able to

1. Acquire knowledge to Design of Data Processing Elements.

2. Design of Control Part of digital logic circuit.
3. Acquire knowledge about Structuring of Logic Design.
4. Identify Clocking Issues in digital system design

### **PVL224: MOS Device Modeling**

The student will be able to

1. Acquire knowledge about physics involved in modelling of semiconductor device.
2. Acquire the basic knowledge about quantum mechanical fundamentals.
3. Model MOSFET devices.
4. Identify characteristics of Advanced Device Technology

### **PVL: Photonics Integrated Devices and Circuits**

The student will be able to

1. Understand the fundamentals, advantages and advances in optical communication and integrated photonic devices and circuits.
2. Introduce optical waveguides, detectors, amplifiers, silicon photonics and MEMS applications in photonics.
3. Design, operate, classify and analyze Semiconductor Lasers, LEDs, modulators and other Integrated photonic devices.
4. Identify, formulate and solve engineering-technological problems related optoelectronic integration.

### **PVL: Memory Design and Testing**

The student will be able to

1. Acquire knowledge about Basics of memory chip Design and Technology.
2. Acquire knowledge about RAM and DRAM Design.
3. Know about On-Chip Voltage Generators.
4. Work using Laplace Trans., CTFT and DTFT.
5. Acquire knowledge about High-Performance Subsystem Memories

### **PVL332: Mixed Signal Circuit Design**

The student will be able to

1. Apply knowledge of mathematics, science, and engineering to design CMOS analog circuits to achieve performance specifications.
2. Identify, formulates, and solves engineering problems in the area of mixed-signal design.
3. Use the techniques and skills for design and analysis of CMOS based switched capacitor circuits.
4. Work as a team to design, implement, and document a mixed-signal integrated circuit.

### **PVL334: High Speed VLSI Design**

The student will be able to

1. Acquire knowledge about High Speed VLSI Circuits Design.
2. Identify the basic Back-End-Of -Line Variability Considerations.
3. Understand the Method of Logical Effort.
4. Understand the Circuit Design Margining and Latching Strategies.
5. Understand the Clocking Styles.

### **PVL: Fault Tolerance in VLSI**

The student will be able to

1. Acquire knowledge about fault tolerance in arithmetic circuits.
2. Learn about Fault diagnosis, Fault tolerance measurement.
3. Acquire knowledge about Fault tolerance strategies.
4. Enhance capabilities about applications of fault tolerant designs in arithmetic units and systems.
5. Acquire knowledge on Software reliability models, and methods.

### **PVL: Sensor Technology and MEMS**

The student will be able to

1. Acquire knowledge about MEMS & Micro Sensors.
2. Understand various micro fabrication technologies.
3. Gather knowledge of characterization tools.
4. Acquire knowledge about Device Applications

### **PVL: Physical Design Automation**

The student will be able to

1. Understand of VLSI Design Automation.
2. Acquire knowledge about CAD tools used for VLSI design.
3. Able to understanding Algorithms for VLSI Design Automation.
4. Able to gather knowledge of High Level Synthesis.
5. Understand Timing Analysis

### **PVL: Advanced Analog Circuit Design Techniques**

The student will be able to

1. Apply knowledge of mathematics, science, and engineering to design and analysis of modern analog integrated circuits.
2. Emphasize the design of practical amplifiers, small systems and their design parameter trade-offs.
3. Understand the relationships between devices, circuits and systems.
4. Participate and function within multi-disciplinary teams.

### **PVL: System on Chip**

The student will be able to

1. Acquire knowledge about Top-down SoC design flow.
2. Understand the ASIC Design flow and EDA tools.
3. Acquire knowledge about Front-end and back-end chip design.
4. Understand the designing communication Networks.
5. Understand the design space exploration.
6. Understand the design methodologies for SoC

### **PVL: Hardware Algorithms for Computer Arithmetic**

The student will be able to

1. Understand power fundamentals: design objective, quantification of energy and power.
2. Work with fast adders.
3. Analyze the issues related to trade-off between cost, speed and accuracy.

4. Work with high throughput, low power algorithms.

### **Course Outcome of M.E (ECE)**

#### **PEC108/109: EMBEDDED SYSTEMS DESIGN**

The students will be able to

1. Recognize the Embedded system and its programming, Embedded Systems on a Chip (SoC) and the use of VLSI designed circuits.
2. Identify the internal Architecture and perform the programming of ARM processor.
3. Program the concepts of Arduino Microcontroller with various interfaces like memory & I/O devices and Raspberry Pi based embedded platform.
4. Analyze the need of Real time Operating System (RTOS) in embedded systems.
5. Recognize the Real time Operating system with Task scheduling and Kernel Objectives.

#### **PEC101: DISCRETE TIME SIGNAL PROCESSING**

1. The students will be able to

2. Recognize the concept of discrete time signal processing and filter design techniques.
3. Analyze the theory of adaptive filter design and its applications.
4. Evaluate the spectra of random signals and variety of modern and classical spectrum estimation techniques.

#### **PEC104: ANTENNA SYSTEMS**

The students will be able to

1. Acquire knowledge about basic antenna concepts.
2. Recognize thin linear antennas and arrays.
3. Identify secondary sources, aperture, broadband and frequency independent antennas.
4. Apply the knowledge of mutual coupling on antennas, applications and numerical techniques.
5. Comprehend the adaptive array concept.

#### **PEC105: ADVANCED COMMUNICATION SYSTEMS**

The students will be able to

1. Recognize Optimum Receivers for AWGN Channels.
2. Analyze the pass band communication and modulation techniques to understand the small scale fading models.
3. Comprehend the concept of Carrier and Symbol Synchronization.
4. Analyse the concept of ISI and its removal.
5. Describe the concept of communication in band limited channels.

#### **PEC106: OPTICAL COMMUNICATION NETWORKS**

The students will be able to

1. Identify, formulate and solve optical communication networks related problems using efficient technical approaches.
2. Design optical networks as well as to interpret statistical and physical data.
3. Design and implement WDM networks.
4. Apply the knowledge to control and manage the functions of optical networks.

5. Recognize the network survivability by various protection schemes.

### **PEC339: IMAGE PROCESSING AND COMPUTER VISION**

The students will be able to

1. Recognize the fundamental techniques of Image Processing and Computer Vision.
2. Interpret the basic skills of designing image compression.
3. Distinguish between different image compression standards.
4. Analyse different computer vision techniques
5. Analyse real time image processing system.

### **PEC207: RF DEVICES AND APPLICATIONS**

The students will be able to

1. Recognize semiconductor device theory at an advanced level including the use of energy band diagram as applied to devices like BJT and MOSFETs.
2. Solve device equations based on equations of continuity and the derivation of C-V and I-V equations of High Frequency devices.
3. Comprehend and develop the equivalent circuit of High Frequency devices and simplify them for analytical work.
4. Carry out the fabrication of devices like SBD, Tunnel diode, DIMOSFET and SiC power devices.

### **PEC211: PASSIVE OPTICAL NETWORKS**

The students will be able to

1. Recognize and evaluate the performance of various enabling technologies used in modern optical networks.
2. Evaluate different WDM network topologies including broadcast-and-select and wavelength routing networks.
3. Design virtual WDM network topologies.
4. Analyze Photonic packet switching networks and time domain optical networking approaches.

### **PEC212: AUDIO AND SPEECH PROCESSING**

The students will be able to

1. Acquire the knowledge about audio & speech signals.
2. Recognize speech generation models.
3. Analyze the audio & speech signal estimation & detection.
4. Acquire knowledge about hardware to process audio & speech signals.
5. Integrate human physiology and anatomy with signal processing paradigms.

### **PEC215: DETECTION AND ESTIMATION THEORY**

The students will be able to

1. Recognize the fundamental concepts of detection and estimation theory involving signal and system models in which there is some inherent randomness and to investigate how to use tools of probability and signal processing to estimate signals and parameters.



2. Identify the optimal estimator/detector or at least bound the performance of any estimator/detector and to study various linear and nonlinear estimation techniques for the detection and estimation of signals with and without noise.
3. Investigate the analytical aspects of various optimum filters/receivers with their system realization and also study various adaptive filters and their mathematical models for detection of Gaussian signals.
4. Apply the concept of white and colored noise with their finite state representation. Also, study is to be done on the time-frequency signal analysis and processing with their various mathematical distribution tools.
5. Evaluate the detection of Doppler-spread targets and the canonical receiver realizations, alongwith the performance of the optimum receiver. Also, study about the models for doubly-spread targets and channels.

### **PEC216: ADVANCED COMPUTER NETWORKS AND PROTOCOLS**

The students will be able to

1. Acquire knowledge about Network Fundamentals.
2. Identify Internetworking.
3. Recognize the Network Standards and Standard Organizations.
4. Interpret the TCP/IP Network Interface Layer Protocol .
5. Acquire knowledge about Routing and Application Layer Protocols.

### **PEC218: DIGITAL SIGNAL PROCESSORS**

The students will be able to

1. Acquire knowledge about Fixed and floating point number systems.
2. Recognize the internal Structures of DSP Processors and memory accesses.
3. Analyse addressing instructions of a DSP processors.
4. Recognize the internal architecture, instructions set, programming and interfacing of different peripheral devices with TMS320C3X, TMS320C5X, TMS320C6X, ADSP 21XX DSP Chips.

### **PEC: MULTIMEDIA COMPRESSION TECHNIQUES**

The students will be able to

1. Recognize and develop human speech mode, understand characteristics of human's visual system, understand the characteristics of human's audio system.
2. Evaluate different compression principles, understand different compression techniques, understand different multimedia compression standards, be able to design and develop multimedia systems according to the requirements of multimedia applications.
3. Analyze the various signal processing aspects of achieving high compression ratios.
4. Recognize and develop new paradigm technologies in audio and video coding.
5. Describe the application of modern multimedia compression techniques in the development of new wireless communication protocols.

### **PEC: FRACTIONAL TRANSFORMS AND APPLICATIONS**

The students will be able to

1. Recognize Time frequency analysis of signals.
2. Describe the concepts of Fractional Fourier Transform.
3. Identify the various applications of Fractional Transform.

4. Evaluate different types of Fractional Fourier Transforms.

### **PEC: OPTOELECTRONICS**

The students will be able to

1. Recognize fundamentals, advantages and advances in optoelectronic devices, circuits and systems.
2. Acquire a detailed understanding of types, basic properties and characteristics of optical waveguides, modulators and detectors.
3. Describe the knowledge of design, working, Classification and analysis of Semiconductor Lasers, LEDs, and modulators.
4. Identify, formulate and solve engineering and technological problems related to optical sources, displays, detectors and optical measurements.

### **PEC: HDL AND SYSTEM C PROGRAMMING**

The students will be able to

1. Design and model digital systems in VHDL and SystemC at different levels of abstraction.
2. Analyse the partition of a digital system into different subsystems.
3. Simulate and verify a design.
4. Synthesize a model from its simulation version.
5. Apply modern software tools for digital design in VHDL.

### **PEC: MICROSTRIP ANTENNAS**

The students will be able to

1. Recognize the basic concept of micro-strip antennas, methods of analysis and configurations.
2. Analyze micro-strip antennas arrays.
3. Evaluate the physical significance of discontinuities.
4. Evaluate the significance of different micro-strip feed mechanism available.
5. Recognize coupled micro-strip line with multiband and broadband behavior.
6. Demonstrate the CPW feeding technique and its implementation.

### **PEC: MACHINE LEARNING**

The students will be able to

1. Differentiate the parametric and non parametric estimations.
2. Recognize data in the pattern space.
3. Design a Trainer and test classifiers using supervised learning.
4. Apply clustering algorithms to process big data real time.
5. Apply Bayesian parameter estimation to real world problems.

### **PEC: ADAPTIVE SIGNAL PROCESSING**

The students will be able to

1. Acquire knowledge about Signals and Systems.
2. Identify Estimation Theory.
3. Describe the Estimation of Waveforms.

4. Recognize system modeling and Identification.
5. Acquire knowledge about Adaptive Filtering.
6. Acquire knowledge about Adaptive Equalization.
7. Acquire knowledge about Non-stationary Signal Analysis and its Applications.

### **PEC: ROBOTICS AND AUTOMATION**

The students will be able to

1. Recognize the basics of robotics and their functionality.
2. Comprehend the fundamentals of sensors.
3. Evaluate various driver systems for robots.
4. Analyze the image processing and computer vision for robotics.
5. Recognize development of algorithms for robot kinematics.

### **PEC: ADVANCED OPTICAL TECHNOLOGIES**

The students will be able to

1. Recognize the Fundamentals, advantages and advances in optical devices and circuits.
2. Describe advanced optical waveguides, detectors, amplifiers, silicon photonics and MEMS applications in photonics.
3. Acquire Knowledge of Design, working, Classification and analysis of Advanced Semiconductor Lasers and High speed modulators.

### **PEC: ARTIFICIAL INTELLIGENCE**

The students will be able to

1. Analyse the applications of artificial intelligence and categorize various problem domains, uninformed and informed search methods.
2. Identify advanced search techniques and algorithms like minimax for game playing.
3. Recognize the importance of probability in knowledge representation for reasoning under uncertainty.
4. Describe Bayesian networks and drawing Hidden Markov Models.
5. Interpret the architecture for intelligent agents and implement an intelligent agent.

### **PEC: BIOMEDICAL SIGNAL PROCESSING**

The students will be able to

1. Recognize the basics of various biomedical signals.
2. Comprehend the fundamentals of processes related to biomedical signals.
3. Analyze various parameters related to biomedical signals.
4. Evaluate data compression and its application in biomedical field.
5. Recognize neurological models of ECG, etc.

### **PEC: CLOUD COMPUTING**

The students will be able to

1. Recognize different cloud architectures.
2. Apply the knowledge of data processing in cloud.
3. Apply clustering algorithms to process big data real time.
4. Identify the security issues in cloud environment.
5. Comprehend the nuances of cloud based services.

### **PEC: RF CIRCUIT DESIGN**

The students will be able to

1. Describe the knowledge about Basic Principles in RF Design.
2. Identify Distributed Systems.
3. Analyse high frequency Amplifier Design.
4. Design Low Noise Amplifier (LNA)
5. Apply the knowledge about Mixers and RF Power Amplifiers.

### **PEC: IP OVER WDM**

The students will be able to

1. Describe the knowledge about protocol design concepts, electro-optic and wavelength conversion.
2. Define Terabit Switching and Routing Network Elements & Optical Network Engineering.
3. Analyze the performance of Traffic Management for IP-over-WDM and Wavelength-Routing Networks.
4. Analyze Internetworking Optical Internet and Optical Burst Switching, Survivability in IP-over-WDM Networks.
5. Differentiate Optical Internetworking Models and Standards Directions.

### **PEC: SOFT COMPUTING TECHNIQUES**

The students will be able to

1. Solve Pattern Classification & Function Approximation Problems.
2. Design appropriate ANN model for a given Problem.
3. Apply data pre-processing techniques.
4. Design Fuzzy inference systems from linguistic models.
5. Design genetic optimization to create objective functions for a given optimization problem.

## Course Scheme-2018 (BE Electrical)

### UEE001: ELECTRICAL ENGINEERING

#### (Cos):

1. Apply networks laws and theorems to solve electric circuits.
2. Analyze transient and steady state response of DC circuits.
3. Signify AC quantities through phasor and compute AC system behaviour during steady state.
4. Explain and analyse the behaviour of transformer.
5. Elucidate the principle and characteristics of DC motor and DC generator.

### UEE507: ENGINEERING ELECTROMAGNETICS

#### (COs):

1. Appraise need analysis for different coordinate systems in electromagnetics and their interrelations.
2. Apply vector calculus to solve field theory problems.
3. Calculate electric and magnetic fields in different coordinates for various charge and current configurations.
4. Exhibit the concept of time varying fields.
5. Demonstrate different aspects of plane wave in dielectric and conducting media.

### UEE404: TRANSMISSION AND DISTRIBUTION OF POWER

#### (COs):

1. Analyse the transmission line models and evaluate its performance parameters.
2. Design the transmission lines under various working conditions.
3. Describe and select the configurations of different line insulators and evaluate their performance.
4. Supervise the laying of cables and fault detection in cables.
5. Design the distribution system network.

### UEE505: ANALOG AND DIGITAL SYSTEMS

#### (COs):

1. Design different type of circuits such as rectifiers, clippers, clampers, filters etc.
2. Design power supplies and solve problems related to amplifiers and oscillators.
3. Design combinational and sequential circuits.
4. Differentiate various type of memories and their use in different applications.
5. Demonstrate the concept of logic circuits and converters.

### UEE301: DIRECT CURRENT MACHINES AND TRANSFORMERS

#### (COs):

1. Test the transformer and calculate its efficiency and performance in distribution system.
2. Compare the performance of auto-transformer with that of two winding transformer.
3. Use special purpose transformer for measurement and protection.
4. Compute the performance of DC motors and generators in various modes.
5. Explain the advantages of increasing load with parallel operation.
6. Explain the speed control and starting methods of DC motors for specific purpose(s).

### UEE407: NETWORK THEORY AND DESIGN

#### (COs):

1. Apply various laws and theorems to solve electric networks.
2. Explain and analyze the behaviour of two port networks.
3. Familiarise with network synthesis.
4. Analyze the behaviour of passive filters and attenuators.
5. Design of passive and active filters.

**UEE406: POWER SYSTEM PRACTICES**

**(COs):**

1. Analyze about energy scenario nationwide and worldwide
2. Decide about energy management in more effective way.
3. Carry out financial management.
4. Analyze about deregulation of power industry.
5. Explain about various pillars of electricity market design.

**UEE401: ALTERNATING CURRENT MACHINES**

**(COs):**

1. Simulate the steady-state and transient state performance of induction and synchronous machines
2. Validate and identify the machine parameters.
3. Select the appropriate AC motor for different large power application.
4. Analyse the stability of single machine – infinite bus system and form the grid to supply large load.
5. Choose the appropriate fractional horse power motor as per the usage in daily life.

**UEE403: MEASUREMENT AND TRANSDUCERS**

**(COs):**

1. Select various types of instruments for measurement of variables.
2. Select and use various types of sensors in different conditions.
3. Select and use various types of bridge circuits with different sensors.
4. Explain the working of electronic instruments.
5. Explain the working of sensors and transducers.

**UEE504: POWER ELECTRONICS**

**(COs):**

1. Select the power devices as per the usage for energy conversion and control.
2. Exhibit the designing of firing and commutation circuits for different converter configurations.
3. Analyse various converter configuration / topology with different types of load.
4. Identify converter configurations for various power applications.
5. Exhibit the usage of power converters for harmonic mitigation, voltage and frequency control.

**CAPSTONE PROJECT**

**(COs):**

**UEE693: Semester VI (starts)**

**UEE795: Semester VII (Completion)**

1. To identify design goals and analyze possible approaches to meet given specifications with realistic engineering constraints.
2. To design an electrical engineering project implementing an integrated design approach applying knowledge accrued in various professional courses.
3. To perform simulations and incorporate appropriate adaptations using iterative synthesis.
4. To use modern engineering hardware and software tools.
5. To work amicably as a member of an engineering design team.
6. To improve technical documentation and presentation skills.

**UEE801: ELECTRIC DRIVES**

**(COs):**

1. Conceptualize the basic drive system and analyse it for different types of loads
2. Analyse the motor situation during starting and braking

3. Develop control circuitry and devices for control of motor
4. Estimate the motor rating for different condition of load
5. Design the converter circuit for control purpose along with its different configuration
6. Use PLC and converter control to drive on the basis of energy efficiency

#### **UEE502: HIGH VOLTAGE ENGINEERING**

##### **(COs):**

1. Conceptualize the idea of high voltage and safety measures involved.
2. Analyse the breakdown mechanism of solids, liquids and gases.
3. Analyse and calculate the circuit parameters involved in generation of high voltages.
4. Measure direct, alternating and impulse high voltage signals.
5. Measure the dielectric loss and partial discharge involved in non-destructive high voltage tests.

#### **UEE605: POWER SYSTEM ANALYSIS AND STABILITY**

##### **(COs):**

1. Develop an appropriate mathematical model of power system.
2. Carry out power flow analysis of practical power system for balanced system.
3. Conduct studies during balanced faults to decide the fault levels and circuit breaker ratings.
4. Conduct studies during unbalanced faults to decide the fault levels and circuit breaker ratings.
5. Analyze the stability of single machine-infinite bus system and can decide the critical clearing time of circuit breakers.

#### **UEE603: SWITCHGEAR AND PROTECTION**

##### **(COs):**

1. Explain various protection strategies applied for power system protection.
2. Select the protection elements namely fuse, circuit breakers and relays for a given configuration.
3. Design the basic Earthing requirement for residential and other purposes.
4. Select required protection measures against overcurrent, overvoltage in transmission lines.
5. Select suitable protection scheme for different power system equipment.

#### **UEE703: DIGITAL SIGNAL PROCESSING FUNDAMENTALS**

##### **(COs):**

1. Explain the digital signal processing concepts and stability analysis of digital system.
2. Demonstrate the hardware architecture of DSP Processor.
3. Design digital filter and harmonic mitigation.
4. Carryout spectrum analysis using DFT.
5. Apply DSP concepts for power system purposes such as relaying, protection and metering

#### **UEE604: FLEXIBLE AC TRANSMISSION SYSTEMS**

##### **(COs):**

1. Describe the converter configuration for different power systems applications such as HVDC, FACTS etc.
2. Evaluate the converters, harmonics on AC and DC side and filtering.
3. Classify various compensators suited for various power system purposes.
4. Analyze power system behaviour with different shunt compensators.
5. Appraise series compensated power system behaviour with different series compensators.
6. Analyse system behaviour with hybrid shunt-series compensators.

#### **UEE804: OPERATION AND CONTROL OF POWER SYSTEMS**

##### **(COs):**

1. Develop small scale model of alternator, excitation and governing systems.
2. Decide the scheduling of thermal units and hydro-thermal units for overall economy.
3. Design and apply control for frequency and voltage of power system represented by multi area.
4. Comprehend power system security and contingency.
5. Computation of small scale and voltage stability.

#### **UEE608: SOFT COMPUTING IN ELECTRICAL ENGINEERING**

##### **(COs):**

1. Examine the fuzzy system and implement fuzzy controllers for control and classification.

2. Explain neural networks behaviour and use them for classification, control system and optimization problem.
3. Obtain the optimum solution of well formulated optimisation problem using evolutionary approach.
4. Develop hybrid system based on integration of neuro and fuzzy system.
5. Formulate hybrid intelligent algorithms for typical electrical application.

**UEE891: PROJECT**

**(COs):**

1. Acquire knowledge and experience of software and hardware practices in the area of project.
2. Carry out design calculations and implementations in the area of project.
3. Associate with the implementation of the project requiring individual and teamwork skills.
4. Communicate their work effectively through writing and presentation.
5. Demonstrate the knowledge of professional responsibilities and respect for ethics.

**UEE806: ALTERNATE SOURCES OF ENERGY**

**(COs):**

1. Explain the basic renewable energy sources like solar, wind, biomass etc
2. Explain various advantages and disadvantages of renewable energy sources.
3. Familiarization with different standalone, off grid energy sources
4. Explain different technology associate with solar, wind, biomass and other renewable energy sources.
5. Describe the working of micro/mini hydropower system.

**UEE631: HVDC TRANSMISSION SYSTEMS**

**(COs):**

1. Choose intelligently AC and DC transmission systems for the dedicated application(s).
2. Identify the suitable two-level/multilevel configuration for high power converters.
3. Select the suitable protection method for various converter faults.
4. Identify suitable reactive power compensation method.
5. Decide the configuration for harmonic mitigation on both AC and DC sides.

**UEE632: POWER GENERATION AND ECONOMICS**

**(COs):**

1. Apply knowledge of India's power scenario, power system structure and related agencies.
2. Explain about various types of power plants i.e., hydro, thermal, gas and nuclear.
3. Harness power from conventional and renewable sources.
4. Select the methods and size of plant generating power for overall economy.
5. Decide the tariff structure for different type of users.

**UEE634: REAL TIME POWER SYSTEMS**

**(COs):**

1. Demonstrate about Hardware-in-loop simulation systems.
2. Explain about mathematical model for power system and control in real environment.
3. Design control schemes for AC and DC electrical machine drives.
4. Demonstrate the concepts of real time control strategy based on FPGA, dSpace.

**UEE892: DESIGN PROJECT**

**(COs):**

1. Acquire knowledge and experience of software and hardware practices in the area of project.
2. Carry out design calculations and implementations in the area of project.
3. Associate with the implementation of the project requiring individual and teamwork skills.
4. Communicate their work effectively through writing and presentation.
5. Demonstrate the professional responsibilities and respect for ethics in university ambiance.

**UEE893: STARTUP SEMESTER**

**(COs):**

1. Demonstrate an ability to develop a business plan.
2. Carry out design calculations/simulations and implementations in the area of project.



3. Develop a prototype/working model/software application.
4. Comprehend the fundamentals of business pitching.
5. Demonstrate the knowledge of professional responsibilities and respect for ethics.

**UEE633: GENERALIZED THEORY OF ELECTRICAL MACHINES**

**(COs):**

1. Express the revolving field and reference frame theory
2. Develop mathematical model of three-phase AC machines and parameters in different reference frame
3. Simulate the transient performance of three-phase ac machines in different reference frames.
4. Investigate the transient performance of different DC machines.
5. Select special purpose small machines for different applications

**UEE524: POWER QUALITY MONITORING AND CONDITIONING**

**(COs):**

1. Reliably identify the sources of various power quality problems.
2. Explain about causes of harmonic and its distortion effect.
3. Estimate the impact of various power quality problems on appliances.
4. Educate the harmful effects of poor power quality and harmonics.
5. Decide the compensators and filters to keep the power quality indices within the standards.

**UEE841: INDUSTRIAL ELECTRONICS**

**(COs):**

1. Simulate and analyse the semiconductor controlled ac and DC drive system.
2. Design and develop an illumination system for domestic, industry and commercial sites.
3. Design an electric heating system for industrial purposes.
4. Equip the skill to design and develop a regulated power supply.
5. Simulate and analyse the series and shunt compensators for power factor improvement in drive system.

**UEE521: ELECTRIC MACHINE DESIGN**

**(COs):**

1. Design DC machines.
2. Design transformers with reduced losses
3. Calculate the losses and efficiency in the machines
4. Analyze and synthesis of computer aided design of electrical machines.
5. Design three phase induction motor.

**UEE850: SMART GRID**

**(COs):**

1. Explain various aspects of the smart grid, including, Technologies, Components, Architectures and Applications.
2. Explain communication infrastructure of smart grid.
3. Explain various integration aspects of conventional and non-conventional energy sources.
4. Explain distributed generation coordination including monitoring of smart grid using modern communication infrastructure.
5. Analyze Microgrid as a hybrid power system with advantages and challenges in future.

# ME-POWER SYSTEM

## ME-PS 2018-19

### **PEE104 Power System Dynamics and Stability**

- To develop the dynamic model of synchronous machine
- To simulate multi-machine dynamic model
- To realise the concepts of small signal stability.
- To investigate the various aspects of energy function methods.
- To carry out the sensitivity analysis of the power system

### **PEE105 Advanced Power Electronics**

- To identify the power semiconductor devices and its utilisation
- To design the Gate and base drive circuits
- To develop skills to utilize the different PWM schemes
- To validate the performance of different types of power converters
- To select the power converter for variety of applications

### **PEE106 Modelling and Analysis of Power System**

- To develop with the mathematical model of power system components
- To carry out power system analysis techniques and optimal power flow.
- To analyse the behavior of system during short circuit and the important of contingency analysis.
- To validate the power system security through simulations

### **PEE107 Power System Transients and Mitigation**

- To understand the causes and effects of switching and lightning surges
- To identify the protection schemes of power system equipment from overvoltages like ground wires, surge absorbers and arrestors.
- To design of insulation of power system components
- To carry out the insulation testing procedures

### **PEE108 Static Protective relaying**

- To knowing static relays and its types.
- To analyse the digital protection schemes for transmission lines, generators and transformers.
- To simulate the protection schemes for radial and mesh connected systems.
- To realize relaying algorithms with different relay settings and on microcontrollers or microprocessors.

### **PEE205 Intelligent algorithms in Power Systems**

- To develop the neuron models with analog and discrete inputs, network architectures and training of network through various learning algorithms in supervised and unsupervised mode.
- To implement the concept of fuzzy logic concept and its implementation in controller applications

<ul style="list-style-type: none"> <li>• To demonstrate the concept of evolutionary computation using Genetic algorithm for decision making problems.</li> </ul>
<p><b>PEE206 Power System Operation &amp; Control</b></p> <ul style="list-style-type: none"> <li>• To understand the power system controls namely load-frequency and AVR control for both single-machine infinite bus system and multimachine systems,</li> <li>• To formulate problems of the optimal system operation through optimal generation dispatch, unit commitment, hydro-thermal scheduling and pumped storage plant scheduling</li> <li>• To implement the optimal power system operation problems through various classical methods.</li> <li>• To analyse the results of optimal dispatch and scheduling</li> </ul>
<p><b>PEE207 Power System Planning and Restructuring</b></p> <ul style="list-style-type: none"> <li>• To understand the concept and significance of power system restructuring and integrated generation.</li> <li>• To formulate the power system generation expansion as an optimization problem with cost, emission and reliability as major constraints</li> <li>• To qualify the technological impacts of transmission &amp; distribution planning under uncertainty factors</li> <li>• To conceptualize the impact of bidding and pricing in competitive electricity markets</li> </ul>
<p><b>PEE212 FACTS Controllers and Modelling</b></p> <ul style="list-style-type: none"> <li>• To understand the power system control through various power electronic controllers including state of art FACTS controllers.</li> <li>• To analyse the operational aspects and their effectiveness in transient stability enhancement,</li> <li>• To assess the issues of damping to power system oscillations, real and reactive power control capability in power system</li> <li>• To learn the integration in power flow analysis and their effectiveness in distribution system for harmonic mitigation etc.</li> </ul>
<p><b>PEE213 Power Quality Monitoring and Conditioning</b></p> <ul style="list-style-type: none"> <li>• To learn aspects of power quality in distribution system, sources of harmonics</li> <li>• To identify the power quality problems</li> <li>• To acquire knowledge about the measures through filtering and static controller,</li> <li>• to know about the harmonic mitigation through multi-level converters</li> </ul>
<p><b>PEE215 Power System Reliability</b></p> <ul style="list-style-type: none"> <li>• Students will acquire the skills to perform reliability analysis of the power system such as generators, transmission lines etc. using analytical simulation tools.</li> <li>• Able to apply knowledge in the domains of stochastic processes for reliability study.</li> <li>• At the higher level of power system security related analysis they will be able to solve the problems through application of security function approach.</li> <li>• Able to analyze the system modes of failure to enhance the power system reliability.</li> </ul>
<p><b>PEE216 Digital Control Systems</b></p> <ul style="list-style-type: none"> <li>• To learn about the discrete digital control system</li> <li>• To perform the stability analysis using various techniques,</li> <li>• To design and develop of PID controller</li> </ul>
<p><b>PEE217 Distribution System Operation and Analysis</b></p> <ul style="list-style-type: none"> <li>• To learn the operational aspects of distribution system</li> <li>• To familiarization with distribution system configurations, loads, power flow,</li> <li>• To analyse the effect of reconfigurations</li> <li>• To learn about the protection in distribution systems.</li> </ul>
<p><b>PEE322 HVAC and HVDC Transmission Systems</b></p> <ul style="list-style-type: none"> <li>• To learn HVAC and HVDC transmission systems.</li> </ul>

<ul style="list-style-type: none"> <li>• To analyse system dynamic performance and reactive power requirements.</li> <li>• To know about corona and radio &amp; TV interference.</li> <li>• To design filters for reduction of harmonics.</li> <li>• To solve power flow equations</li> </ul>
<p><b>PEE302 Electric Drives and Control</b></p> <ul style="list-style-type: none"> <li>▪ To acquire the knowledge of selection of drives as per practical operational industrial requirement.</li> <li>▪ To apply their knowledge to prepare control schemes as per different types of motors used in industries.</li> <li>▪ To estimate &amp; solve harmonic and power factor related problems in controlling AC and DC drives.</li> </ul>
<p><b>PEE305 Load and Energy Management</b></p> <ul style="list-style-type: none"> <li>• To be familiar with different load forecasting method used in power system,</li> <li>• To understand different phase of load management and impacts of load management</li> <li>• To understand the concept of energy demand and method to satisfy meet the energy demand</li> <li>• To understand the measurement of energy conservation and its case studies</li> <li>• To be familiar with ways of saving electricity in different utilities. Different phase of energy audit.</li> <li>• To understand the role of energy management and energy forecasting</li> </ul>
<p><b>PEE306 State Estimation and Supervisory Control</b></p> <ul style="list-style-type: none"> <li>• To understand the SCADA organization and structure.</li> <li>• To implement the concept of state estimation, multi-area state estimation.</li> <li>• To understand the smart grid concepts and its application</li> <li>• To familiarise with the concept of smart grid, micro grid, smart metering and virtual power plant</li> </ul>
<p><b>PEE308 Renewable Energy Systems</b></p> <ul style="list-style-type: none"> <li>• To be familiar the current status of generation of energy(both renewable and nonrenewable ) in India and worldwide</li> <li>• To understand different conversion ,solar and wind to electricity , Wind and Solar Technology in detail.</li> <li>• To understand the basic of converter used in Wind and Solar</li> <li>• To understand the designing of Solar panel , grid connection issues To be familiar with different ways to store electricity and their applications</li> </ul>
<p><b>PEE309 Power Quality and Custom power</b></p> <ul style="list-style-type: none"> <li>• To understand power quality standards.</li> <li>• To identify linear and non linear loads.</li> <li>• To know about various measurement techniques of voltage and current paparmeters.</li> <li>• To analyse harmonics and their mitigation</li> </ul> <p>To acquire knowledge of custom power devices and their role in T&amp;D system.</p>
<p><b>PMA Computational Techniques and Statistical Methods</b></p> <ul style="list-style-type: none"> <li>• To apply conventional techniques of direct search to solve un constrained optimisation problems</li> <li>• To solve constrined optimisation problems.</li> <li>• To apply ANOVA test to assess the degree of variance,</li> <li>• To analyse design of experiments through variance and covariance estimates</li> <li>• To apply the concept of proabilibility to understand the frequency of occurrence and adequacy estimate.</li> </ul>
<p><b>PEE301 Digital Signal Processing and Applications</b></p> <ul style="list-style-type: none"> <li>• To learn to apply z-transform and FFT analysis</li> <li>• To analyse continuous and discrete signals in frequency domain.</li> <li>• To implement the concepts for measurement of frequency, harmonic level etc.</li> <li>• To design digital filters for reduction of noise signals</li> <li>• To apply concepts of DSP to power system protection for measurement of signals</li> </ul>
<p><b>PEE303 High voltage Technology</b></p> <ul style="list-style-type: none"> <li>• To understand the causes of occurrence high voltage and travelling waves.</li> <li>• To knowing the different devices used for protection against high voltage Testing HV cables.</li> <li>• To learn about characteristics of Air and SF<sub>6</sub> and performance of GIS.</li> </ul>
<p><b>PEE304 Digital Controllers and Applications</b></p>

- To develop controller application using DSP programming concept..
- To identify the architecture of processor concepts for I/O.
- To develop speed controller of motor using FPGA.

**PEE307 Power System Operation Under Deregulation**

- To understand issues related to whole sale electricity market.
- To make comparison estimation of prevailing open access transmission models.
- To conceptualise the wheeling of power and price strategies
- To understand the electricity business

## **2018 BE-EIC: Course Scheme**

### **UEE503 NETWORK ANALYSIS AND SYNTHESIS**

- Describe various laws and theorems related to electric networks.
- State the concept of two port networks.
- Familiarise with network synthesis.
- Elucidate Foster and Cauer forms of LC Networks
- **Interpret passive network synthesis**

### **UEI407 SIGNALS AND SYSTEMS**

- Apply sampling theorem for different applications
- Solve problems related to Fourier transforms
- Apply Fourier transforms for different applications
- Apply z-transform and Laplace transform for system characterization
- Elucidate the concepts of random signals

### **UEI408 ANALOG DEVICES AND CIRCUITS**

- Differentiate between different diodes on the basis of their working principle.
- Elucidate the working principle of BJT and FET
- Explain the analysis of transistor amplifier using h-model and analyse the effect of feedback on amplifiers.
- Design the oscillator circuit.

### **UEI409 DIGITAL SIGNAL PROCESSING AND APPLICATIONS**

- Analyze the signals in time and frequency domain
- Apply the transformation tools on signals and systems and analyze their significance and applications.
- design the structures of different types of digital filters
- design various digital filters and analyze their frequency response
- Analyse finite word length effects.

### **UEI403 ELECTRICAL AND ELECTRONIC MEASUREMENTS**

- Explain the working of different electromechanical indicating instruments.
- Elucidate the concept of several AC bridges for inductance and capacitance
- Describe basic working of instrument transformers.
- Measure power and energy with the help of wattmeter and energy meter.
- Describe the construction and working of various electronic instruments.

### **UEI608 BIO-MEDICAL INSTRUMENTATION**

- differentiate and analyse the biomedical signal sources.
- elucidate cardiovascular system and related measurements.
- explain the respiratory and nervous systems and related measurements

- measure non-invasive diagnostic parameters.
- Describe diagnostic instrumentation

#### **UEI501 CONTROL SYSTEMS**

- develop the mathematical model of the physical systems.
- analyze the response of the closed and open loop systems.
- analyze the stability of the closed and open loop systems.
- design the various kinds of compensator.
- develop and analyze state space models

#### **UEI301 DIGITAL ELECTRONICS**

- Differentiate between different number systems and various codes
- Apply minimization techniques for the simplification of Boolean functions
- Design the combinational and sequential circuits.
- Compare the different analog to digital converters.
- **Elucidate the concept of memories and logic circuits**

#### **UEI610 FUNDAMENTALS OF MICROPROCESSORS AND MICROCONTROLLERS**

- Elucidate the architecture and addressing modes of 8-bit microprocessor.
- Elucidate the architecture and addressing modes of 8051 microcontroller.
- Perform assembly language programming for microprocessors and microcontrollers for the given application.
- Use hardware interfacing of 8051 to develop solutions of real world problems.

#### **UEI507 SENSORS AND SIGNAL CONDITIONING**

- Apply different methods for the measurement of length and angle
- Elucidate the construction and working of various industrial parameters / devices used to measure pressure, sound and flow
- Explicate the construction and working of various industrial parameters / devices used to measure temperature, level, vibration, viscosity and humidity
- Ability to analyse, formulate and select suitable sensor for the given industrial applications
- Describe signal conditioning circuits

#### **UEE609 ELECTRIC MACHINE AND DRIVES**

- derive expressions for forces and torques in electromechanical devices
- understand how power electronic converters and inverters operate
- possess an understanding of feedback control theory
- analyze and compare the performance of DC and AC machines in various drive applications
- design controllers for electric drives which achieve the regulation of torque, speed, or position in the above machines.

#### **UEI601 INDUSTRIAL INSTRUMENTATION**

- illustrate the different methods for the measurement of length and angle
- elucidate construction & working of various industrial devices used to measure pressure, sound & flow
- explicate the construction and working of various industrial devices used to measure temperature, level, vibration, viscosity and humidity
- to analyze, formulate and select suitable sensor for the given industrial applications

- summarize different methods for level measurement

#### **UEI605 PROCESS DYNAMICS AND CONTROL**

- demonstrate fundamental understanding of process control.
- develop the mathematical model of various chemical processes.
- explain different control modes and their application in controlling various processes.
- explain the working of electric, hydraulic and pneumatic controllers.
- demonstrate the working and application of different type of actuators and control valves

#### **UEI624 REHABILITATIVE ENGINEERING**

- Apply Orthopedics, Cardiology, Exercise Physiology, Surgery, Biomechanics in Orthopaedics
- Engineer rehabilitation engineering anthropometry
- Use sensory rehabilitation engineering concepts.
- Rehabilitation using orthopedic prosthetics and orthotics in
- Handle applications of active prostheses.

#### **UEI831 BIOSENSORS AND MEMS**

- explain the concept of molecular reorganization, fundamentals of surfaces and interfaces
- elucidate the principles of different types of biosensors
- explain the concept of MEMS design, and fabrication technology
- explain bioinstrumentation and bioelectronics devices.
- explain the different types of MEMS and its applications

#### **UEI833 OPTICAL INSTRUMENTATION**

- explain the basic concepts of optical transmitting and receiving
- describe different opto- electronic devices
- elucidate different methods of interferometry
- describe selection of the appropriate optical fiber sensors for industrial application
- EXPLAIN FIBRE OPTIC FUNDAMENTALS

#### **UEI847 ROBOTICS AND AUTOMATION**

- explain the fundamentals of robotics and its components
- illustrate the Kinematics and Dynamics of robotics
- elucidate the need and implementation of related Instrumentation & control in robotics
- illustrate the movement of robotic joints with computers/microcontrollers.
- Explain sensors and instrumentation in robotics

#### **UEI841 ADVANCED CONTROL SYSTEMS**

- demonstrate non-linear system behaviour by phase plane and describing function methods and the
- perform the stability analysis nonlinear systems by Lyapunov method develop design skills in optimal control problems
- derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform).
- predict and analyze transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems.
- acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers



## **UEI625 ANALOG AND DIGITAL COMMUNICATION**

### **UEI401 ARTIFICIAL INTELLIGENT TECHNIQUES AND APPLICATIONS**

- explain the concept of artificial neural networks and its learning techniques.
- apply back propagation algorithm for different applications
- express fuzzy sets, membership functions and knowledge representation using fuzzy rules.
- explain basics of expert systems.
- use genetic algorithms for single and multiple objective optimization problems

### **UEI801 ADVANCED PROCESS CONTROL**

- explain the concept of advanced control schemes used in process control.
- explain the working of distributed control system
- elaborate the use of artificial intelligence techniques in process control.
- explain the fundamental concepts of PLC.
- explain the concept of digital control system.

### **UEI701 DATA ACQUISITION AND SYSTEM DESIGN**

- elucidate the elements of data acquisition techniques.
- design and simulate signal conditioning circuits.
- explain various data transfer techniques
- explain the components of data acquisition system
- differentiate between single and multi-channel

### **UEI718 VIRTUAL INSTRUMENTATION**

- demonstrate the working of LabVIEW.
- explain the various types of structures used in LabVIEW.
- analyze and design different type of programs based on data acquisition.
- demonstrate the use of LabVIEW for signal processing, image processing etc.
- use different analysis tools

### **UEI720 ANALYTICAL INSTRUMENTATION**

1. explain the concept of spectrometry and optical techniques
2. elucidate the working of chromatography, elemental analyser
3. illustrate the working of X- ray diffractometer and scanning electron microscope
4. explain the concept of potentiometry and its applications
5. describe the working of different electrodes

### **UEI721 DIGITAL IMAGE PROCESSING**

- Explain the fundamentals of digital image and its processing
- Perform image enhancement techniques in spatial and frequency domain.
- Elucidate the mathematical modelling of image restoration and compression
- Apply the concept of image segmentation.
- Describe object detection and recognition techniques.

### **UEI723 EMBEDDED SYSTEMS DESIGN**

### **UEI724 COMPUTER ARCHITECTURE AND OPERATING SYSTEMS**

- explain about the basics of computer functioning
- elucidate the concepts of operating system of the machines
- get insight into the hardware and software interactions
- Build their knowledge for low level programming

**UEI805 ENVIRONMENTAL INSTRUMENTATION**

- explain sources and effects of air and water pollutants
- explain air pollution sampling and measurement techniques
- explain water sampling and analysis techniques
- explain solid waste management and noise level measurement techniques
- describe solid waste management techniques

## ME-EIC Course Scheme 2018

### PEI108: MICROCONTROLLERS AND EMBEDDED SYSTEMS

#### Course learning outcome (CLO):

- Learn basic hardware of various microcontrollers.
- Assembly and programming concepts, jump and call instructions.
- Hardware interfacing of microcontroller with led's, seven segment, sensors.
- Introduction to 16-bit microcontrollers.

### PEI107: DIGITAL SIGNAL PROCESSING TECHNIQUES

**Course learning outcome (CLO):** After the completion of the course the students will be able to:

- Identify various type of discrete signal and systems.
- Analyse frequency domain response of systems.
- Design various type of filter.
- Implement filter structures.

### PEI102: INDUSTRIAL INSTRUMENTATION AND CONTROL

**Course learning outcome (CLO):** After the completion of the course the students will be able to:

- Acquire knowledge about industrial instrumentation and control
- Handle PLC and DCS system
- Programme and analyze robotic system
- Interface the hardware and software through buses for process control system

### PEI109: INTELLIGENT TECHNIQUES AND APPLICATIONS

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Apply artificial intelligence and expert system concepts to control process.
- Use of evolutionary computation algorithm to solve engineering problems.

- Acquire knowledge about hybrid search techniques.
- Apply intelligent techniques in process control, robotics and industrial control systems.

#### **PEI110: MEASUREMENT TECHNIQUES**

**Course learning outcome (CLO):** After the completion of the course the students will be able to:

- Apply different techniques for the analysis of errors
- Analyse the response of systems for various test signals
- Explain different sensors and signal conditioning circuits.
- Elucidate techniques for the measurement of the Shaft Power Torque, speed, vibration, Viscosity, pH, and Humidity
- Examine various techniques for the measurement of Temperature, Pressure, and Flow.

#### **PEI104: PROCESS MODELING AND CONTROL**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Perform static and dynamic analysis of existing instrumentation system
- Implement advanced control schemes for different process.
- Design multi-loop controllers and digital controller and model discrete event system.
- Analyse the system using state space analysis.
- Apply fundamentals to real time control problems.

#### **PEI201: BIOMEDICAL INSTRUMENTATION AND TECHNIQUES**

**Course learning outcome (CLO):** After the completion of the course the students will be able to:

- Study characteristics of transducers and electrodes for biological measurement.
- Understand cardiac system and respiratory system.
- Apply instrumentation system for measuring nerve function parameter.
- Apply ECG and neurological signal processing for analysis.
- Apply telemedicine concepts for handling distant patients.

#### **PEI211: DIGITAL IMAGE PROCESSING AND ANALYSIS**

**Course learning outcome (CLO):** After the completion of the course the students will be able to:

- *Understand the concept of digital image processing.*
- Apply image smoothing and spatial filtering for images.
- Study and analyze the performance through frequency domain analysis.

- Apply image restoration, compression, segmentation and morphological image processing.

### **PEI216: OPTIMAL AND ROBUST CONTROL**

**Course learning outcome (CLO):** After the completion of the course the students will be able to:

- Apply Parametric Optimization
- Apply Calculus of variations for optimization problems.
- Apply of Pontryegans Max/min Principle for optimization.
- Apply Dynamic Programming in Continuous and Discrete Time systems
- Apply iterative method of optimization
- Analyze and design a robust Control System

### **PEI204: VIRTUAL INSTRUMENTATION AND APPLICATIONS**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Apply graphical programming
- Identify elements of data acquisition for software and hardware installation
- Apply signal processing, sampling signals and filtering
- Handle network interface layer protocol, system buses, interface buses.
- Implement and design machine vision and motion control.

### **PEI306: EMBEDDED SYSTEM FUNDAMENTALS AND PROGRAMMING**

**Course learning outcome (CLO):** After the completion of the course the students will be able to:

- Implement basic hardware of HCS12/S12X series Microcontrollers.
- Handle HCS12 System Programming and Serial Peripheral Interface Interfacing to Keypad, Motors, Graphic lcds.
- Implement the Networking and Connectivity
- Handle Development and Programming Tools, Hardware and Software development tools, C language
- Implement Real-time Operating Systems

### **PEI307: INDUSTRIAL ELECTRONICS**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Handle knowledge about solid state devices
- Design industrial electronic converters and devices
- Handle industrial application of industrial electronic devices and their control
- Test drive controllers, microprocessor based drive controllers and their analysis

- Implement power conditioner and applications

### **PEI205: MICRO-SENSORS AND ACTUATORS**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Design MEMS system.
- Handle Magnetic MEMS for process applications.
- Use Bio-MEMS for process measurements.

### **PEI215: REMOTE SENSING AND TELEMETRY**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Study remote sensing applications.
- Use components of telemetring and remote control systems
- Use data acquisition and distribution system, digital modulation and demodulation techniques in telemetry system

### **PEI311 ROBOTIC TECHNOLOGY**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Handle robot components and study its characteristics
- Learn about robot kinematics.
- Analyze the differential motions, inverse manipulator kinematics.
- Perform robot dynamic analysis and trajectory planning.
- Use actuators and sensors in robot.

### **PEI301: ADVANCED SOFT COMPUTING TECHNIQUES**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Apply soft computing techniques to solve engineering problems.
- Handle multi-objective optimization problems.
- Apply advanced AI techniques of swarm intelligence , particle swarm optimization, ant-colony optimization and petrinets.
- Apply rough set theory and granular computing to solve process control applications

### **PEI303: BIOMETRICS TECHNIQUES**

**Course learning outcome (CLO): After the completion of the course the students will be able to**

- Apply biometric matching for identification
- Identify algorithms for finger biometric technology
- Apply facial biometrics for identification.
- Apply iris biometric, voice biometric, physiological biometrics etc. for identification.

### **PEI305: COMPUTATIONAL ELECTROMAGNETIC**

**Course learning outcome (CLO): After the completion of the course the students will be able to**

1. Apply partial differential equation and time-domain methods for analysis.
2. Apply one-dimensional scalar wave equation
3. Handle the concept of maxwell's' equations and yee algorithm
4. Apply the numerical stability schemes
5. Apply the numerical dispersion techniques.

### **PEI329: EMBEDDED CONTROL SYSTEMS**

**Course learning outcome (CLO): After the completion of the course the students will be able to**

1. Express the building block of microcontrollers and specifically S12X architecture.
2. Elucidate the C-programming using IDE like code warrior for S12X microcontroller and can develop the programs for timers, PWM etc.
3. Demonstrate the interfacing modules (ADC, LCD etc.) in control applications.
4. Express understanding of real time operating system.

### **PEI308: MICROCONTROLLER BASED SYSTEM DESIGN**

**Course learning outcome (CLO):**

- Review 8-bit microcontrollers
- Implement assembly and c-program of ARM microcontrollers.
- Design of basic circuits for ARM microcontroller.
- Design interfacing circuits for ARM microcontroller.

### **PEI302: BIOMECHANICS AND REHABILITATION**

**Course learning outcome (CLO): After the completion of the course the students will be able to**

- Apply Orthopedics, Cardiology, Exercise Physiology, Surgery, Biomechanics in Orthopaedics

- Engineer rehabilitation engineering anthropometry
- Use sensory rehabilitation engineering concepts.
- Rehabilitation using orthopedic prosthetics and orthotics in
- Handle applications of active prostheses.

### **PEI207: COGNITIVE ENGINEERING**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Acquire basic knowledge of cognitive neuroscience.
- Acquire basic knowledge of psychophysiology
- Acquire basic knowledge of functional neuro-imaging of cognition and image processing
- Apply signal processing and neural engineering in relation to cognitive engineering.
- *Design experiments related to cognitive engineering*

### **PEI213: ENVIRONMENT MONITORING INSTRUMENTATION**

**Course learning outcome (CLO):** After the completion of the course the students will be able to:

- Study air pollution sources and its effects
- Analyse air pollution sources and its effects
- Investigate sources and classification of water pollution
- Perform air pollution sampling and measurement, air pollution control methods and equipment, air sampling techniques
- Monitor and audit management, noise level measurement techniques, instrumentation for environmental pollution

### **PEI310: POWER SYSTEM INSTRUMENTATION**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Identify energy storage methods
- Work on transmission lines and instrumentation scheme used for HVDC
- Handle automatic generation and voltage control in power generation station.
- Identify instrumentation schemes for monitoring and control
- Apply signal transmission techniques for sharing process information

### **PEI327: SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL**

**Course learning outcome (CLO):** After the completion of the course the students will be able to

- Develop input output process model, state space process models and discrete time process models.



- Use the concept of least square methods and recursive least square method.
- Solve optimal control problem and design of optimal controller.
- Design adaptive control system.

### **PEI312: ULTRASONIC AND OPTO-ELECTRONIC INSTRUMENTATION**

#### **Course learning outcome (CLO):**

- Use ultrasonic based instrumentation.
- Use opto-electronics for signal conditioning.
- Use optical techniques and spectrometric methods of analysis

# **CHEMICAL ENGINEERING**

CLOs of each courses.

Course Name	Course Learning Outcomes (CLOs)
UCB008 Applied Chemistry	CLO 1: Analyze trends in periodic table with electronic and atomic structure
	CLO 2: Interpret phase diagrams of pure and binary substances.
	CLO 3: Demonstrate the working of electrodes and their applications.
	CLO 4: Calculate various parameters defining water and fuel quality
	CLO 5: Identify the various functional groups through IR spectra.
	CLO 6: Carry out basic experimental procedure and to emphasize need for safety and safety procedure in laboratory.
UEC001 Electronic Engineering	CLO 1: Understand working of various diodes and their applications.
	CLO 2: Understand working of transistors and operational amplifiers, their configuration and applications.
	CLO 3: Understand number systems and Boolean algebra.
	CLO 4: Minimize Boolean expressions with Karnaugh-maps/ algebra and their implementation with logic gates.
	CLO 5: Analyze, design and implement combinational and sequential circuits.
	CLO 6: Understand differences between logic families, TTL and CMOS.
UEE001 Electrical Engineering	CLO 1: Apply networks laws and theorems to solve electric circuits.
	CLO 2: Represent AC quantities through phasor and compute AC system behaviour during steady state
	CLO 3: Explain principle and characteristics of Electro-Mechanical energy conversion devices and apply them.
UEN009 Energy & Environment	CLO1. Correlate major local and regional environmental issues with changes in ecology and human health
	CLO2. Monitor and document the development and dynamics of ecosystems in experimental or natural microcosms
	CLO3. Define and document local resource consumption patterns and conservation strategies

	CLO4. Define opportunities available for energy conservation and for use of renewable energy resources in local and regional entities.
UES009 Mechanics	CLO 1: The students will be able to determine resultants in plane force systems
	CLO 2: Identify and quantify all forces associated with a static framework
	CLO 3: Solve problems in kinematic and dynamic systems
UES011 Thermofluids	CLO1: analyze and solve problems of simple fluid based engineering systems including pressures and forces on submerged surfaces
	CLO2 :analyze fluid flow problems with the application of the mass, momentum and energy equations
	CLO3 : evaluate practical problems associated with pipe flow systems
	CLO4 : conceptualize and describe practical flow systems such as boundary layers and their importance in engineering analysis
	CLO5: estimate fluid properties and solve basic problems using property tables, property diagrams and equations of state
	CLO6: analyze and solve problems related to closed systems and steady-flow devices by applying the conservation of energy principle
	CLO7: analyze the second law of thermodynamics for various systems and to evaluate the performance of heat engines, refrigerators and heat pumps.
UES012 Engineering Materials	CLO1: Classify engineering materials based on its structure.
	CLO2: Draw crystallographic planes and directions.
	CLO3: Distinguish between elastic and plastic behavior of materials.
	CLO4: Distinguish between Isomorphous and eutectic phase diagram.
	CLO5: Classify materials based on their electrical and magnetic properties.
	CLO6: Propose a solution to prevent corrosion.
UHU003 Professional Communication	CLO 1: Understand and appreciate the need of communication training
	CLO 2: Use different strategies for effective communication
	CLO 3:Select the most appropriate mode of communication for a given situation.

	CLO 4: Speak assertively and effectively
	CLO5:Correspond effectively through different modes of written communication.
	CLO 6:Write effective reports, proposals and papers.
	CLO 7:Present himself/ herself professionally through effective resumes and Interviews
UHU005 Humanities For Engineers	CLO1: Improve the understanding of human behavior with the help of interplay of professional, psychological and economic activities.
	CLO2: Able to apply the knowledge of basic principles of psychology, economics and ethics for the solution of engineering problems.
	CLO3: Explain the impact of contemporary issues in psychology, economics and ethical principles on engineering.
UMA003 Mathematics – I	CLO1: apply the knowledge of calculus to plot graphs of functions and solve the problem of maxima and minima.
	CLO2: determine the convergence/divergence of infinite series, approximation of functions using power and Taylor’s series expansion and error estimation.
	CLO3: evaluate multiple integrals and their applications to engineering problems.
	CLO4: examine functions of several variables, define and compute partial derivatives,directional derivatives and their use in finding maxima and minima.
	CLO 5: analyze some mathematical problems encountered in engineering applications
UMA004 Mathematics-II	CLO 1: solve the differential equations of first and 2nd order and basic application problems described by these equations.
	CLO 2: find the Laplace transformations and inverse Laplace transformations for various functions. Using the concept of Laplace transform students will be able to solve the initial value and boundary value problems.
	CLO 3: find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and wave equations.
	CLO 4: solve systems of linear equations by using elementary row operations.
	CLO 5: identify the vector spaces/subspaces and to compute their bases/orthonormal bases. Further, students will be able to express linear transformation in terms of matrix and find the eigen values and eigen vectors

UMA007 Numerical Analysis	CLO1: Understand the errors, source of error and its effect on any numerical computations and also analysis the efficiency of any numerical algorithms.
	CLO2: Learn how to obtain numerical solution of nonlinear equations using bisection, secant, Newton, and fixed-point iteration methods.
	CLO3: Solve system of linear equations numerically using direct and iterative methods.
	CLO4: Understand the methods to construct interpolating polynomials.
	CLO5: Learn how to solve definite integral and initial value problem numerically.
UPH004 Applied Physics	CLO 1: Understand damped and simple harmonic motion, the role of reverberation in designing a hall and generation and detection of ultrasonic waves
	CLO 2: Use Maxwell's equations to describe propagation of EM waves in a medium.
	CLO 3: Demonstrate interference, diffraction and polarization of light.
	CLO 4: Explain the working principle of Lasers.
	CLO 5: Use the concept of wave function to find probability of a particle confined in a box.
	CLO 6: Perform an experiment, collect data, tabulate and report them and interpret the results with error analysis
UTA007 Computer Programming –I	CLO 1: Write, compile and debug programs in C++ language.
	CLO 2: Use different data types, operators and console I/O function in a computer program
	CLO 3: Design programs involving decision control statements, loop control statements and case control structures.
	CLO 4: Understand the implementation of arrays, pointers and functions and apply the dynamics of memory by the use of pointers
	CLO 5: Comprehend the concepts of structures and classes: declaration, initialization and implementation
	CLO 6: Apply basics of object oriented programming, polymorphism and inheritance.
	CLO 7: Use the file operations, character I/O, string I/O, file pointers, pre-processor directives and create/update basic data files.
UTA008	CLO 1: Creatively comprehend geometrical details of common engineering objects

Engineering Design-I	CLO 2: Draw dimensioned orthographic and isometric projections of simple engineering objects.
	CLO 3: interpret the meaning and intent of toleranced dimensions and geometric tolerance symbolism;
	CLO 4: Create the engineering drawings for simple engineering objects using AutoCAD
	CLO 5: Manage screen menus and commands using AutoCAD
	CLO 6: Operate data entry modes and define drawings geometrically in terms of Cartesian, polar and relative coordinates in AutoCAD.
	CLO 7: Create and edit drawings making selections of objects, discriminating by layering and using entities, object snap modes, editing commands, angles and displacements using AutoCAD.
	UTA009 Computer Programming-II
	CLO2: Implement decision statements and looping statements.
	CLO3: Grasp the concepts of input and output handling from console, files and internet in Java.
	CLO4: Create frames, windows, containers, GUI components in Java and handle events for building GUI
	CLO5: develop GUI applications
UTA010 Engineering Design-II	CLO1. simulate trajectories of a mass with and without aerodynamic drag using a spreadsheet based software tool to allow trajectories be optimised;
	CLO2. perform a test to acquire an engineering material property of strength in bending and analyse the throwing arm of the “Mangonel” under conditions of static and dynamic loading;
	CLO3. develop and test software code to process sensor data;
	CLO4. design, construct and test an electronic hardware solution to process sensor data;
	CLO5. construct and operate a Roman catapult “Mangonel” using tools, materials and assembly instructions, in a group, for a competition;
	CLO6. operate and evaluate the innovative redesign of elements of the “Mangonel” for functional and structural performance.
UTA011 Engineering Design-III	CO1: Understand of features of Arduino board.
	CO2: Analyze of internal Architecture of Arduino board.

	CO3: Apply Arduino board programming concepts.
	CO4: Design and implement Buggy project based on different goals and challenges defined.
UCH301 Material and Energy Balances	CLO1: Perform material balance for problems without chemical reactions.
	CLO 2: Perform material balance for problems involving chemical reactions.
	CLO3: Perform energy balance for problems without chemical reactions.
	CLO 4: Perform energy balance for problems involving chemical reactions.
UCH302 Process Fluid Mechanics	CLO 1: Calculate shear force, pressure, and various kinematic quantities
	CLO 2: Analyse fluid flow problems involving the application of the momentum and energy equations
	CLO 3: analyze fluid flow problems with dimensional analysis
	CLO4: Solve the problems related to pipe flows and fluid machinery
UCH303 Chemical Engineering Thermodynamics	CLO1: apply fundamental concepts of thermodynamics to engineering applications.
	CLO2: estimate thermodynamic properties of substances in gas and liquid states.
	CLO3: determine thermodynamic efficiency of various energy related processes.
UCH304 Chemical Technology-I	CLO1: Understand the processes involved in the manufacturing of various inorganic chemicals.
	CLO2: Prepare the process flow diagrams.
	CLO3: Analyze important process parameters and engineering problems during production
UCH401 Fluid and Particle Mechanics	CLO 1: solve and analyze problems of size reduction and solid-solid separation methods
	CLO 2: analyze and design of equipment handling fluid-particle systems
	CLO 3: analyze mixing process, and sizing of hoppers and bins and selection of suitable solid conveying systems
	CLO4: analyze and solve problems related to flow through beds of solids
	CLO5: solve the problems related to compressible fluids, and fluid machinery
UCH402 Heat Transfer	CLO 1: solve problems related to diffusion and interphase mass transfer and mass transfer equipment
	CLO 2: Perform design calculation related to absorption and humidification.
	CLO 3: solve problems related to drying and crystallization
UCH403 Chemical Technology-II	CLO1: Identify various operations involved in the manufacturing of different organic chemicals.
	CLO2: Know the important process parameters and solve engineering problems during production.
	CLO3: Identify the limitations and advantages of various manufacturing processes.
UCH501 Chemical Reaction Engineering-I	CLO1: Develop rate laws for homogeneous reactions.
	CLO2: Analyze batch reactor data by integral and differential methods.
	CLO3: Design ideal reactors for homogeneous single and multiple reactions.
	CLO4: Select the appropriate type reactor/scheme.
	CLO5: Demonstrate the temperature effect on reaction rate and design non-isothermal reactors.
UCH502 Mass Transfer – I	CLO1: solve problems related to diffusion and interphase mass transfer and mass transfer equipments
	CLO2: perform design calculation related to absorption and humidification.
	CLO3: solve problems related to drying and crystallization
UCH503 Industrial Pollution Abatement	CLO1: Quantify and analyze the pollution load.
	CLO2: Analyze/design of suitable treatment for wastewater.
	CLO3: Model the atmospheric dispersion of air pollutants.
	CLO 4: Selection and design of air pollution control devices.



	CLO 5: Analyze the characteristics of solid waste and its handling & management.
UCH504 Energy Technology	CLO1: Analyze the energy scenario of the world
	CLO2: Carry out a comparative analysis of different types of coal, including their treatment, liquefaction and gasification
	CLO3: Compare the liquid and gaseous fuels sourced from petroleum including their characterization
	CLO4: Analyze the potential of alternate energy sources and their scope and limitations
	CLO5: Solve energy related problems related to combustion and non-combustion
UCH505 Process Equipment Design-I	CLO 1: Determine the parameters of equipment design and important steps involved in equipment fabrication
	CLO 2: Design internal pressure vessels and their heads
	CLO 3: Design flange joints, vessel supports, expansion joints, expansion loop, etc.
	CLO 4: Design internal pressure thick vessels and external pressure vessels
	CLO 5: Design tall vessels and storage vessels
UCH506 Process Instrumentation & Control	CLO1: Set up a model, analyse and solve the first and second order system for its dynamic behaviour
	CLO2: Evaluate the process stability in Laplace domain
	CLO3: Design control system using frequency response analysis
	CLO4: Identify advanced control techniques for chemical process.
UCH601 Chemical Reaction Engineering – II	CLO1: predict the conversion in a non-ideal reactor using tracer information.
	CLO2: design reactors for fluid-solid reactions.
	CLO3: design reactors for catalytic reactions.
	CLO4: design towers for gas–liquid reactions with and without mass transfer considerations.
UCH602 Mass Transfer – II	CLO1: Use the phase equilibrium concepts in mass transfer related problems.
	CLO2: Design staged /packed column for mass transfer operations.
	CLO3: Solve problems related to adsorption.
	CLO4: Solve problems related to liquid-liquid and solid-liquid extraction.
UCH603 Transport Phenomena	CLO1: Analyze heat, mass, and momentum transport in a process.
	CLO2: Formulate problems along with appropriate boundary conditions.
	CLO3: Develop steady and transient solution for problems involving heat, mass, and momentum transport
UCH604 Biochemical Engineering	CLO1: Calculate the kinetic parameters of enzymatic reactions.
	CLO2: Calculate and analyze the kinetic parameters for microbial growth.
	CLO3: Analyze bioprocess design and operation.
	CLO4: Select suitable bioreactor.
UCH605 Process Utilities and Industrial Safety	CLO1: Calculate the requirements of water and air and their applications as utilities.
	CLO2: Calculate the steam requirement and its applications as utility.
	CLO3: Evaluate and apply the various risk assessment methods in industries
	CLO4: Do the hazard analysis for different industries using HAZOP
UCH606 Process Equipment design – II	CLO1: Identify important design aspects.
	CLO2: Design different types of heat transfer equipment.
	CLO3: Design different types of mass transfer equipment.
	CLO4: Design piping system.
UCH701	CLO1: Develop various catalytic reaction mechanisms.

Catalytic Processes	CLO2: Characterize a catalyst.
	CLO3: Assess the effects of external heat and mass transfer in heterogeneous catalysis.
	CLO4: Calculate the effectiveness of a porous catalyst.
	CLO5: Design different types of reactors for catalytic reactions.
UCH712 Distillation Processes	CLO1: Use the shortcut method for binary and multicomponent distillation.
	CLO2: Solve problems related to binary and multi-component distillation.
	CLO3: Use of operational and design aspects of enhanced distillation processes.
	CLO4: Use the concepts of column sequencing for efficient separation.
UCH721 Food Technology	CLO 1: Identify causes of food spoilage and selection of suitable food preservation method
	CLO 2: Identify and evaluate various parameters associated with unit operation involved in food industries
	CLO 3: Analyze food quality and effect of processing technique and packaging/storage on it
	CLO 4: Analyze food related hazards and HACCP method
UCH801 Process Engineering and Plant Design	CLO 1: Apply various algorithms to synthesize a process flow sheet.
	CLO 2: Calculate different costs involved in a process plant.
	CLO 3: Calculate interest and time value of investments.
	CLO 4: Measure profitability on investments.
	CLO 5: Perform breakeven analysis and optimum design of a process.
UCH802 Process Modeling and Simulation	CLO1: Analyze physical phenomena involved in various processes
	CLO2: Develop mathematical models for various chemical processes
	CLO3: Use various simulation approaches
	CLO4: Simulate a process using simulators (Aspen Plus/Aspen Hysys)
UCH832 CFD Analysis in Chemical Engineering	CLO1: Solve PDE.
	CLO2: Use Finite Difference and Finite Volume methods in CFD modeling.
	CLO3: Generate and optimize the numerical mesh.
	CLO4: Simulate simple CFD models and analyze its results.
UCH836 Energy Management in Process Industries	CLO1: know the components involved in energy auditing.
	CLO2: know energy conservation and waste heat recovery techniques.
	CLO3: evaluate the performance of industrial boilers and furnaces.
	CLO4: identify the scope for recycle and reuse of water.
UCH844 Petroleum Technology	CLO1: Quantify and analyze the pollution load.
	CLO2: know the properties and specification of petroleum products.
	CLO3: acquired knowledge of different separation processes involved in petroleum refinery.
	CLO 4: acquired knowledge of various conversion processes involved in petroleum refinery.
UCH845 Polymer Technology	CLO 1: Compare the various polymer synthesis techniques.
	CLO 2: Apply the structure-processing-property relationship of polymers towards optimization of properties.
	CLO 3: Analyze the various processing and manufacturing techniques.
	CLO 4: Carry out a comparative analysis of the basic issues involved in polymer blends, composites and nanocomposites.

### 2.6.1 School of Chemistry and Biochemistry

The program educational objectives (PEOs) and program outcomes (POs) are defined for our Masters' program that are available at the forefront of the respective scheme and syllabi. Additionally, the course outcomes (COs) of each course are listed in the respective courses that are communicated to the students during their induction and during the course introduction by the respective instructor. All of these information are also available on the website of the school. Following is the link:

[http://thapar.edu/upload/files/M.Sc.Chemistry\\_Syllabus\\_2018.pdf?\\_ga=2.76842833.510970279.1533725614-511445330.1494350727](http://thapar.edu/upload/files/M.Sc.Chemistry_Syllabus_2018.pdf?_ga=2.76842833.510970279.1533725614-511445330.1494350727)

# **School of Energy and Environment**

## **M.Tech. (Energy Technology & Management)**

### **Program Objectives**

- To prepare the students for successful career in the energy industry; energy regulation and management agencies; and in the academic and R&D institutions.
- To produce graduates strong in energy resources, technologies and management fundamentals, and capable in addressing the present and potential future energy problems.
- To produce energy professionals, who are sensitive to, and well aware of, the energy issues and concerns, and who can apply their specialized knowledge for the sustainable energy management.

### **Program Outcomes (POs)**

- Understood and acquired fundamental knowledge on the science of energy and on both the conventional and non-conventional energy technologies
- Acquired the expertise and skills needed for the energy monitoring, auditing and management, and for the development, implementation, maintenance and auditing of Energy Management Systems
- Become capable of analysis and design of energy conversion systems
- Acquired skills in the scientific and technological communications, and in the preparation, planning and implementation of energy projects

## **PET107: ADVANCED THERMODYNAMICS AND HEAT TRANSFER**

### **Course Learning Outcomes:**

The students will be able to

- Design and analysis of heat exchangers, evaporators with aim to improve their performance and economy
- Able to execute the exergy analysis for understanding the given physical device and process, compute the work and heat transfer and formulate the ideal approximation to the behaviour.
- Apply principles of heat transfer to basic engineering design systems with understanding of how processes affect the environment

## **PET104: FLUID MECHANICS AND FLUID MACHINERY**

### **Course Learning Outcomes:**

- Acquiring scientific and technological understanding on the different aspects of fluid flow.
- Gaining skills to calculate head losses in different fluid flow measurement devices.
- Ability to design the hydraulic machines and its selection criteria.

## **PET103: ENERGY, ENVIRONMENT AND CLIMATE CHANGE**

### **Course Learning Outcomes:**

**Upon completion of this course, the students will be able to:**

- Acquire scientific and technological understanding on the energy aspects and associated environmental issues
- Understand the environmental impacts of energy technologies
- comprehend the concepts of climate change and related protocols
- learn modalities as well as procedures for CDM projects

## **PET102: ENERGY POLICY AND LEGISLATION**

### **Course Learning Outcomes:**

- Able to gain appropriate knowledge on various policies and legislations associated with energy administration.

- Gaining awareness on policies that facilitate development of energy conservation strategies and methods.
- Becoming aware of the Energy Acts and of the legal energy requirements applicable to the various industrial sectors

## **PET101: CONVENTIONAL ENERGY TECHNOLOGIES**

### **Course Learning Outcomes:**

- Ability to identify, track and solve various combustion problems and evaluate theoretically the performance of various components involved in thermal power plants.
- Gaining appropriate knowledge on principal of operation, construction and working of power plants equipment and components.
- Becoming aware of the appropriate technologies used in the power plants and integration of the thermal energy management system

## **PET101: CONVENTIONAL ENERGY TECHNOLOGIES**

### **Course Learning Outcomes:**

- Ability to identify, track and solve various combustion problems and evaluate theoretically the performance of various components involved in thermal power plants.
- Gaining appropriate knowledge on principal of operation, construction and working of power plants equipment and components.
- Becoming aware of the appropriate technologies used in the power plants and integration of the thermal energy management system.

## **PET105: RENEWABLE ENERGY TECHNOLOGIES**

### **Course Learning Outcomes:**

- Gaining appropriate knowledge on principles of operation, construction and working of solar photovoltaics and solar thermal devices.
- Ability to design solar thermal and wind energy conversion system for appropriate applications.

- Gaining comprehensive knowledge of how performance of solar and wind energy can be evaluated.

## **PMA102: RESEARCH METHODOLOGY**

### **Course Learning Outcomes:**

- Acquiring skills for formulating research problems and hypotheses to be tested, and for the preparation and presentation of research/project proposals.
- Obtaining the knowledge of probability and data distribution functions and becoming capable of estimating mathematical expectations.
- Acquiring the skills of regression and correlation analysis, development of statistical models, and calibration, validation and use of the models.
- Becoming capable of design of experiments for investigations and hypotheses testing relating to research problems and projects.
- Getting acquainted with the commercially available software packages for the statistical data analysis.

## **PET201: RENEWABLE ENERGY TECHNOLOGIES-II**

### **Course Learning Outcomes:**

- Gaining knowledge on the operation, working and technological advances in wind, ocean, tidal, geothermal and mini/micro hydel power generation systems.
- Describe the challenges and problems associated with the use of biomass, ocean, tidal and geothermal energy sources and mini/micro hydel power with regard to the future supply and the environment.
- Discuss remedies/potential solution to the supply and environmental issues associated with the unconventional oil and gas energy resources.

## **PET202: ELECTRICAL SYSTEMS**

### **Course Learning Outcomes:**

At the end of the course, the student shall be able to -

- Explain the concepts of AC electric system.
- Apply power factor correction for energy saving by capacitor and STATCOM.
- Estimate the harmonics and apply mitigation through STATCOM.
- Comprehend the operation and control of power system, power system protection and substation practices.

## **PET203: ENERGY CONSERVATION AND MANAGEMENT**

### **Course learning outcomes:**

- Awareness on the energy crisis and environmental concerns and on the importance of energy efficiency, conservation and management
- knowing the techniques and having the skills for the energy conservation and management in the thermal energy systems
- knowing the techniques and having the skills for the energy conservation and management in the electrical energy systems
- Basic knowledge on energy monitoring and auditing, and on the energy management systems
- Exposure to the most used energy planning and management softwares

## **PET211: HYDROGEN FUEL AND FUEL CELL TECHNOLOGY**

### **Course Learning Outcomes:**

- Gaining appropriate knowledge on hydrogen production technological route through fossil fuel and renewable resources.
- Gaining awareness on working, construction and performance evaluation of various fuel cells.
- Describe the challenges and problems associated with the use of hydrogen and fuel cell technology with regard to the safety aspects and the environment



## **PET212: BIO-ENERGY AND TECHNOLOGIES**

### **Course Learning Outcomes:**

- Able to understand the challenges and problems associated with the use of various bioenergy sources with regard to future resource and the environment.
- Able to evaluate the cost-benefit of various biomass energy conversion processes.
- Able to identify remedies/potential solutions to the supply and environmental issues associated with biomass based energy resources.

## **PET213: SOLAR ENERGY AND TECHNOLOGIES**

### **Course Learning Outcomes:**

- Gaining appropriate knowledge on solar energy based thermal power plant
- Gaining awareness on working, construction and performance evaluation of solar photovoltaic and solar thermal devices
- Describe the challenges and problems associated with the use of solar energy and its impacts on environment

## **PET221: ENERGY MANAGEMENT SYSTEMS AND AUDITING**

### **Course Learning Outcomes:**

- Able to carry out development, implementation and maintenance of ISO 50001 based Energy Management System.
- Able to utilize the techniques and skills of Energy Management System Auditing.
- Able to utilize the techniques and skills of energy analysis of organizations and development of energy baseline of organizations.

## **PET222: ELECTRICAL ENERGY AND MANAGEMENT**

### **Course Learning Outcomes:**

- Becoming aware of typical electrical energy powered machinery and equipment of organizations, specially the industrial units.
- Having the knowledge and awareness of the tools and techniques and the management practices for the conservation and management of electrical energy in organizations.
- Acquiring the techniques and skills of electrical energy analysis and identification of opportunities and options for electrical energy conservation and management.

## **PET223: THERMAL ENERGY AND MANAGEMENT**

### **Course Outcomes:**

- Having basic understanding of combustion process and knowledge of on-site thermal energy generation systems, insulation and typical thermal utilities and services of organizations.
- Becoming aware of the structure and functioning of thermal energy systems of industrial units and organizations.
- Student acquired the techniques and skills of thermal energy analysis and identification of opportunities and options for the thermal energy conservation and management

# **School of Energy and Environment**

## **M.Tech. (Environmental Science and Technology)**

### **Program Objectives:**

- To prepare the students for successful career in the industry; regulatory agencies, departments and boards; consulting firms; and academic and R&D institutions of international standard
- To produce the graduates strong in Environmental Science and Technology fundamentals, and capable in addressing the diverse present and potential environmental problems
- To produce the environmentalists who are sensitive to and well aware of the environmental concerns, issues and problems, and who can apply their specialized and modern environmental knowledge for the environmentally sound development.
- To lay firm foundation for environmental managers who can work in multidisciplinary and interdisciplinary teams and who understand the language of both masses and the specialists from different disciplines.

### **Program Outcomes:**

- Acquiring fundamental knowledge and understanding of environmental sciences
- Acquiring basic environmental monitoring skills, including design and conduct of experiments and data analysis
- Having fundamental knowledge of environmental technologies, and acquiring capabilities for the design, diagnosis and analysis of pollution control systems and devices, and of water supply and wastewater engineering
- Acquiring abilities and capabilities in the areas of development and implementation of environmental management systems, and environmental analysis, environmental aspects identification and environmental impacts assessment
- Obtain basic understanding on the aspects closely related with the environment, such as, energy, climate change, ISO 14001 based management systems and auditing, and project management

## **PMA102 RESEARCH METHODOLOGY**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- acquire skills for formulating research problems and hypotheses to be tested, and for the preparation and presentation of research/project proposals
- interpret probability and data distribution functions and becoming capable of estimating mathematical expectations
- analyse regression and correlation analysis, development of statistical models, and calibration, validation and use of the models
- design of experiments for investigations and hypotheses testing relating to research problems and projects
- acquaint with the commercially available software packages for the statistical data analysis

## **PES105 ATMOSPHERIC SCIENCES, METEOROLOGY AND CLIMATE CHANGE**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- interpret the basic phenomenon of atmospheric sciences
- demonstrate a detailed knowledge of study the effect of meteorological parameters in the dispersion of air pollutants
- comprehend the concepts of climate change and related protocols
- interpret modalities as well as procedures for CDM projects

## **PIN103: REMOTE SENSING AND GIS**

### **Course Learning Outcomes (CLOs):**

The student will be able to:

- design the various processes involved in remote sensing
- processes the raw data and prepare the final product after necessary corrections
- interpret the remotely sensed data
- learn the use geospatial data for the benefit of the end users

## **PES107 ENVIRONMENTAL SCIENCES**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- apply basic concepts of structural and functional features of environmental systems
- determine the chemistry of soils, pollutants and exchange of nutrients in various biogeochemical cycles
- interpret significance of biological and biochemical mechanisms associated with functioning of environmental systems
- apply analytical tools associated with environmental biodegradation and bioremediation
- apply analytical tools for determining extent of toxicity

## **PES108 SOLID WASTE MANAGEMENT**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- estimate the environmental pollution and nuisance potential of municipal solid waste and of special category wastes
- interpret the regulatory requirements applicable for handling and management of municipal solid wastes and special category wastes
- demonstrate the knowledge of procedures, practices and technologies of management and handling (collection, reception, storage, treatment/processing, transportation and disposal) of solid wastes

## **PES109 WATER AND WASTEWATER TREATMENT TECHNOLOGIES – I**

### **Course Learning Outcomes:**

The students will be able to:

- decide on the scheme of treatment for water
- design, analyze, operate and control the routinely used physico-chemical water treatment units
- monitor the water treatment plants and characterize water samples

## **PES204 WATER AND WASTEWATER TREATMENT TECHNOLOGIES – II**

### **Course Learning Outcomes:**

The students will be able to:

- decide on the scheme of treatment for wastewaters
- design, analysis, operate and control the routinely used biological wastewater treatment units
- monitor the wastewater treatment plants and characterize the wastewater samples
- decide on the facilities and provisions for the handling and management of the water and wastewater treatment sludges

## **PES205 AIR POLLUTION CONTROL ENGINEERING**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- apply the basic concepts of fluid and particle mechanics
- design industrial ventilation systems
- decide and design air pollution control devices for removal of particulates from flue gases
- demonstrate the designing and operation of various air pollution control devices for the removal of gaseous pollutants from both stationary as well as mobile sources

## **PES213 ENVIRONMENTAL SAFETY AND MANAGEMENT**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- identify, classify and characterize different hazardous materials and wastes
- implementation of the rules and regulations pertaining to the handling and management of hazardous materials and wastes
- develop the emergency preparedness and response plans and programs with the ability to identify hazard and risk assessment
- cover the basic aspect of the occupational health and safety management systems and their essential elements

## **PES223 WATERSHED MANAGEMENT**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- demarcate and characterize watersheds
- analyze the watersheds and understand the issues and concerns associated with them, and to frame the watershed management objectives
- analyze the hydrological and remote sensing data
- examine best management practices for the sustainable management of watershed

## **PES224 INDUSTRIAL ENVIRONMENT MANAGEMENT SYSTEMS**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- identify and evaluate environmental aspects of any organization's activities, products and services
- understand legal and other environmental requirements applicable to organizations
- establish, document, implement, maintain and improve EMS in organizations

## **PES225 ENVIRONMENT LEGISLATION AND IMPACT ASSESSMENT**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- comprehend the environmental legislation, environmental policies of the country and of the international environmental conventions and protocols
- examine the environmental regulations applicable to the industry and other organizations with significant environmental aspects
- estimate the environmental requirements applicable to the environmental impact assessment, and about the environmental clearance process of developmental projects
- interpret the methods and tools of identification, prediction and evaluation of environmental impacts of developmental projects

## **PES231 CLEANER TECHNOLOGIES**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- comprehend basic concepts in source reduction and waste management
- design viable cleaner production systems utilizing steps and skills acquired
- examine and evaluate present and future advancements in emerging and renewable energy technologies

## **PES232 WATER QUALITY MONITORING AND MODELING**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- have good understanding and knowledge of water quality guidelines, criteria and standards
- implement water quality monitoring programs, develop water quality indexes and analyse & interpret water quality data
- modal water bodies for different water quality parameters, and run some of the conventional water quality models

## **PES233 AIR QUALITY MONITORING AND MODELING**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- Interpret the guidelines for an air quality monitoring
- apply techniques employed in the monitoring of particulates and gaseous pollutants in ambient air
- comprehend monitoring of particulates and gaseous pollutants in stack gas
- predict ground level concentration of pollutants from a given source through air quality modeling

## **PES241 ENVIRONMENTAL HYDRAULICS AND HYDROLOGY**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- apply fluid mechanics to water supply and sewerage systems, to water and wastewater treatment plants, and to air pollution control systems



- comprehend facilities and provisions (pumps, blowers, mixers, flow measurement devices) required for the handling of fluids (water, wastewater and gaseous emissions)
- examine techniques and skills on fluid flow measurement and quantification
- apply concepts of fluid mechanics to storm water handling and management

## **PET203 ENERGY CONSERVATION AND MANAGEMENT**

### **Course Learning Outcomes (CLOs):**

The students will be able to:

- correlate the energy crisis and environmental concerns with the energy efficiency, conservation and management
- apply techniques and skills for the energy conservation and management in the thermal and electrical energy systems
- apply tools associated with energy monitoring and auditing, and on the energy management systems
- apply skills acquired in energy planning and management softwares for data analysis and interpretation

## **PES390 SEMINAR**

### **Course Learning Outcomes (CLOs):**

The student will be able to

- Identify and understand assumptions and arguments that exist in the national and international literature in the identified area of work/topic
- evaluate and synthesize evidence in order to draw conclusions based on research gaps
- ask meaningful questions and originate plausible research and technical gaps and the implications of the expected outcomes

**SCHOOL OF  
HUMANITIES**

**&**

**SOCIAL  
SCIENCES**

## **2.6.1 –**

### **PhD Programme**

#### **Program Outcomes (PO)**

PO 1: To make them able for research and development opportunities.

PO 2: To prepare them for teaching and research positions.

PO 3: To refine their social and behavioral skills so that they can contribute for societal welfare.

PO4: To empower them in research and guidance abilities to enable them to independently carry out social and academic research.

## **Master of Arts (Psychology)**

### **Program outcomes**

- To adopt a scientifically minded orientation to evaluate information presented to them, and conduct and disseminate methodologically sound research relevant to the practice of psychology.
- To critically evaluate scientific information relevant to the field of clinical and counseling psychology and to use appropriate research methodology to test scientific hypotheses relevant to their area.
- To apply theory-based and empirically supported approaches to assessment and intervention.
- To develop knowledge of mental disorders/psychosocial impairments and skills to diagnose mental disorders.
- To understand theory associated with different assessment methods and develop competence in assessment and report writing.
- To develop the knowledge and skills to apply current approaches to psychological intervention, including empirically supported techniques, relevant to their areas.
- Enter into careers as professional psychologists competent in psychological assessment, intervention, research and evaluation in teaching and practice settings.

## **Masters of Arts (Economics)**

### **Programme Outcomes (PO)**

A student after completing the Master's programme will be able to acquire knowledge in the following areas and demonstrate their ability to:

PO 1: To equip students with the tools of the professional economist, for working in government, international organizations, business, or as for pursuing doctoral research in economics.

PO 2: To provides the basis for acquiring special focus within the related fields and sub fields of Economics

PO 3: To hone their quantitative skills, this Program offers courses in Mathematics, Statistics and Econometrics.

PO 4: To assist in understanding and applying Economic Theories for Economic Modeling and Forecasting in the real world

PO 5: To know the market better and to analyze the situation as per the market requirements.

PO 6: To expose them to emerging policy issues at the national and international levels.

PO 7: To enhance the analytical and problem solving skills as well as exposure to emerging policy issues at the national and international levels.

PO8: To help in developing critical thinking skills by analyzing economic information and develop solutions to economic problems.

## **‘Humanities for Engineers’ (UHU005)**

### **Course Outcome and Course-specific Objectives**

The course ‘Humanities for Engineers’ is taught to the students with the intention that upon the successful completion of this course, students will be able to demonstrate improved understanding of human behaviour, especially with reference to the interplay of professional, psychological and economic activities that humans undertake. The students will be able to apply the knowledge of basic principles of psychology, economics and ethics in the solution of engineering problems. The course would enable students to examine the impact of contemporary issues in psychology, economics and ethical principles on engineering. The mechanism to ensure effective delivery of content includes lecture and practical classes. The lectures focus on students’ learning through interaction and discussions on the topic. The practical classes help students to critically analyse various subjects. The evaluative activities in the practical classes include role plays, group discussions and a project which is research-oriented.

## **Professional Communication (UHU003)**

**Course objective:** To introduce the students to effective professional communication. The student will be exposed to effective communication strategies and different modes of communication. The student will be able to analyse his/ her communication behavior and that of the others. By learning and adopting the right strategies, the student will be able to apply effective communication skills, professionally and socially.

### **Course learning outcome (CLO):**

- 1.Understand and appreciate the need of communication training.
- 2.Use different strategies of effective communication.
- 3.Select the most appropriate mode of communication for a given situation.
- 4.Speak assertively and effectively.
- 5.Correspond effectively through different modes of written communication.
- 6.Write effective reports, proposals and papers.

### 2.6.1 School of Mathematics

The school offers M.Sc. (Mathematics and Computing) and Ph.D programme. Besides these, school also offers several mathematics courses to B.E., M. E., M. Tech and MCA students. The school is committed to provide quality teaching with modern infrastructure and syllabus.

#### Vision and mission of school of mathematics

- To be recognized as global excellence model in research and education in Mathematics.
- To offer Professional degree programs in Mathematics designed to develop full professional potential of students.
- To produce proficient graduates for employment in technologically challenging areas in academia and industry.
- To provide foundational support in mathematics for various academic programs across the institute.
- To carry out quality research in pure and applied mathematics.
- To ensure the attainment of goals in accordance with the institute's thrust and directions.

#### M.Sc Mathematics and Computing:

**Name of Programme:** Master of Science (Mathematics and Computing)

**Program Objective:** The objectives of the M.Sc. (Mathematics and Computing) program are to

1. create a platform for higher studies and research in mathematics, computing and inter-disciplinary areas.
2. develop sound analytical and practical knowledge to take up jobs in Software, Finance Industry, Research and Teaching.
3. prepare students to qualify various national and international competitive examinations.

**Program Educational Outcome:** The successful completion of this program will enable the students to

1. acquire the knowledge and understanding of the pure mathematics covering analysis and algebra and ability to apply this knowledge in other fields.
2. use of applied mathematics courses such as Numerical Analysis, Operations Research, Probability and Statistics; and Mechanics to solve real life problems.
3. Join software and IT industry with sound knowledge of programming and mathematics based computing.
4. pursue research as a career in mathematics, computing and inter-disciplinary fields.

#### SCHEME OF COURSES FOR M.Sc. (Mathematics and Computing)

##### List of Core Courses:

<u>S. No.</u>	<u>Course No.</u>	<u>Course Name</u>	<u>Course Objectives</u>	<u>Course Learning Outcomes:</u>



				Upon completion of this course, the student will be able to:
1	PMC107	Real Analysis – I	The aim of this course is to introduce the students real number system and metric spaces. In particular, the notion of completeness, compactness, limit, continuity, differentiability, integrability and uniform continuity.	<ol style="list-style-type: none"> <li>1) Understand basic properties of <math>\mathbb{R}</math>, such as its characterization as a complete and ordered field, Archimedean Property, density of <math>\mathbb{Q}</math> and <math>\mathbb{R}/\mathbb{Q}</math> and unaccountability of each interval.</li> <li>2) Classify and explain open and closed sets, limit points, convergent and Cauchy convergent sequences, complete spaces, compactness, connectedness, and uniform continuity etc. in a metric space.</li> <li>3) Know how completeness, continuity and other notions are generalized from the real line to metric spaces.</li> <li>4) Recognize the difference between pointwise and uniform convergence of a sequence of functions.</li> <li>5) Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability and integrability.</li> <li>6) Determine the Riemann-Stieltjes integrability of a bounded function and prove a selection of theorems and concerning integration.</li> </ol>
2	PMC108	Algebra-I	The objective of the course is to introduce basic structures of algebra like groups,	<ol style="list-style-type: none"> <li>1) Explore the properties of groups, sub-groups, including symmetric groups, permutation groups, cyclic groups,</li> </ol>

			rings and fields which are the main pillars of modern mathematics.	<p>normal sub-groups and quotient groups.</p> <ol style="list-style-type: none"> <li>2) Understand the concepts of homomorphism and isomorphism between groups.</li> <li>3) Apply class equation and Sylow theorems to solve different problems.</li> <li>4) Explore the properties of rings, sub-rings, ideals including integral domain, principle ideal domain, Euclidean ring and Euclidean domain.</li> <li>5) Understand the concepts of homomorphism and isomorphism between rings.</li> </ol>
3	PHU002	Professional Communication	To provide the students with the essential skills required for effective communication and a comprehensive view of business communication and its role in the corporate environment.	<ol style="list-style-type: none"> <li>1) Understand and demonstrate the use proper writing techniques relevant to the present day technological demands, including anticipating audience reaction,</li> <li>2) Write effective and concise letters and memos,</li> <li>3) Prepare informal and formal reports,</li> <li>4) Proofread and edit copies of business correspondence</li> <li>5) Develop interpersonal skills that contribute to effective personal, social and professional relationships</li> </ol>
4	PMC104	Fundamentals of Computer Science and C Programming	The aim of this course is to provide adequate knowledge of fundamentals of	<ol style="list-style-type: none"> <li>1) Recognize and understand the purpose of basic computer components</li> </ol>

			computer along with problem solving techniques using C programming. This course provides the knowledge of writing modular, efficient and readable C programs. Students also learn the utilization of arrays, structures, functions, pointers and implement these concepts in memory management. This course also teaches the use of functions and file systems.	<ol style="list-style-type: none"> <li>2) Implement of simple 'C' program, data types and operators and console I/O function</li> <li>3) Understand decision control statements, loop control statements and case control structures.</li> <li>4) Understand the declaration and implementation of arrays, pointers, functions and structures.</li> <li>5) To understand the file operations, character I/O, String I/O, file pointers and importance of pre-processor directives.</li> </ol>
5	PMC105	Discrete Mathematical Structure	Prepare students to develop mathematical foundations to understand and create mathematical arguments, require in learning many mathematics and computer sciences courses. To motivate students how to solve practical problems using discrete mathematics	<ol style="list-style-type: none"> <li>1) Construct mathematical arguments using logical connectives and quantifiers.</li> <li>2) Validate the correctness of an argument using statement and predicate calculus.</li> <li>3) Understand how lattices and Boolean algebra are used as tools and mathematical models in the study of networks.</li> <li>4) Learn how to work with some of the discrete structures which include sets, relations, functions, graphs and recurrence relation.</li> </ol>
6	PMC106	Differential Equations	The main aim of this course is to understand various analytical methods to find exact solution of ordinary and partial differential equations and their implementation to	<ol style="list-style-type: none"> <li>1) Learn how the differential equations are used to study various physical problems such as mass attached to spring and electric circuit problem etc.</li> <li>2) Obtain power series solutions of several</li> </ol>

			solve real life problems.	<p>important classes of ordinary differential equations including Bessel's, Legendre, Gauss's hypergeometric and Chebyshev's differential equations.</p> <ol style="list-style-type: none"> <li>3) Understand the Sturm-Liouville problem and analyze stability of linear and non-linear systems.</li> <li>4) Solve the first-order linear and non-linear PDE's by using Lagrange's and Charpit's methods respectively.</li> <li>5) Determine the solutions of linear PDE's of second and higher order with constant coefficients.</li> <li>6) Classify second order PDE and solve standard PDE using separation of variable method.</li> </ol>
7	PMC201	Real Analysis –II	The aim of the course is to introduce the students Lebesgue measure, measurable sets and their properties, measurable functions and their properties and Lebesgue integral.	<ol style="list-style-type: none"> <li>1) Understand how Lebesgue measure on <math>\mathbb{R}</math> is defined,</li> <li>2) Understand basic properties are measurable functions,</li> <li>3) Understand how measures may be used to construct integrals,</li> <li>4) Know the basic convergence theorems for the Lebesgue integral,</li> <li>5) Understand the relation between differentiation and Lebesgue integration.</li> </ol>

8	PMC205	Data Base Management System	<p>The major objective of this course is to provide a strong formal foundation in database concepts, technology and to give an introduction to systematic database design approaches covering conceptual design, logical design and an overview of physical design. This course will also introduce the concepts of transactions and transaction processing to present the issues and techniques relating to concurrency and recovery. The overriding concern, is present the concepts and techniques by SQL engine and PL/SQL programming.</p>	<ol style="list-style-type: none"> <li>1) Understand, appreciate and effectively explain the underlying concepts of database technologies.</li> <li>2) Design and implement a database schema for a given problem-domain.</li> <li>3) Populate and query a database using SQL DML/DDDL commands.</li> <li>4) Programming PL/SQL including stored procedures, stored functions, cursors, packages.</li> </ol>
9	PMC209	Numerical Analysis	<p>The course is intended as a basic course in numerical analysis. The objective of the course is to familiarize the students about different numerical techniques e.g. solving algebraic and transcendental equations, large linear system of equations, differential equations, approximating functions by polynomials upto a given desired accuracy, finding</p>	<ol style="list-style-type: none"> <li>1) Understand the errors, source of error and its effect on any numerical computations and also analysis the efficiency of any numerical algorithms.</li> <li>2) Learn how to obtain numerical solution of nonlinear equations using bisection, secant, Newton and fixed-point iterations methods and convergence analysis of these methods.</li> <li>3) Solve linear and nonlinear systems of equations numerically.</li> </ol>

			<p>approximate value of definite integrals of functions etc. The course also throws light on the convergence analysis of these techniques and explains different types of errors which gets involved and propagates during numerical computations. Also students will be able to understand the advantages/disadvantages of numerical techniques.</p>	<ol style="list-style-type: none"> <li>4) Apply numerical methods to find eigen value and eigen vectors.</li> <li>5) Handle the functions and data set using interpolation and least square curves.</li> <li>6) Evaluate the integrals numerically.</li> <li>7) Learn how to solve initial and boundary value problems numerically.</li> </ol>
10	PMC210	Data Structures and Algorithms	<p>This course shall help the students in understanding how to analyze a given algorithm. This course will also help them in making the choice of data structures and methods to design algorithms that affect the performance of programs. They will also learn to solve problems using data structures such as linear lists, stacks, queues, etc. and shall be writing programs for these structures.</p>	<ol style="list-style-type: none"> <li>1) Analyze a given algorithm for its complexity.</li> <li>2) Appreciate the role of data structures in different implementations.</li> <li>3) Implement algorithm design techniques to different problems</li> </ol>
11	PMC103	Complex Analysis	<p>This course is aimed to provide an introduction to the theories to functions of a complex variable. In particular, students</p>	<ol style="list-style-type: none"> <li>1) Represent complex numbers algebraically and geometrically,</li> <li>2) Define and analyze limits and continuity for</li> </ol>

			will acquire the skill of contour integration to evaluate complicated real integrals via residue calculus.	<p>functions of complex variables,</p> <ol style="list-style-type: none"> <li>3) Understand about the Cauchy-Riemann equations, analytic functions, entire functions including the fundamental theorem of algebra,</li> <li>4) Evaluate complex contour integrals and apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula,</li> <li>5) Analyze sequences and series of analytic functions and types of convergence,</li> <li>6) Represent functions as Taylor and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem'</li> <li>7) Understand the conformal mapping.</li> </ol>
12	PMC211	Computer Organization and Operating systems	The course aims to shape the attitudes of learners regarding the field of computer organization as well as operating system. Specifically, the course aim to i) Have the insight of computer organizations and the working of operating systems ii) Instill the belief that computer organization as well as	<ol style="list-style-type: none"> <li>1) Understand, appreciate and effectively explain the underlying concepts of computer organization.</li> <li>2) Have the idea about instruction set, instruction cycle, RISC as well as CISC.</li> <li>3) Know the process management, scheduling and deadlock.</li> <li>4) Understand the memory management, and file system.</li> </ol>

			operating is important for IT professional.	
13	PMC305	Mathematical Methods	This course is intended to prepare the student with mathematical tools and techniques that are required in advanced courses offered in the applied mathematics and engineering programs. The objective of this course is to enable students to apply transforms and variation problem technique for solving differential equations and extremum problems.	<ol style="list-style-type: none"> <li>1) Laplace Transformation to solve initial and boundary value problems.;</li> <li>2) To learn Fourier transformation and Z transformation and their applications to relevant problems.;</li> <li>3) To understand Hankel's Transformation to solve boundary value problem.;</li> <li>4) Find solutions of linear integral equations of first and second type (Volterra and Fredhlo)</li> <li>5) Understand theory of calculus of variations to solve initial and boundary value problems.</li> </ol>
14	PMC306	Probability and Statistics	The course aims to shape the attitudes of learners regarding the field of statistics. Specifically, the course aims to i) motivate students towards an intrinsic interest in statistical thinking, ii) instill the belief that statistics is important for scientific research.	<ol style="list-style-type: none"> <li>1) Compute the probabilities of composite events using the basic rules of probability.</li> <li>2) Demonstrate understanding the random variable, expectation, variance and distributions.</li> <li>3) Explain the large sample properties of sample mean.</li> <li>4) Understand the concept of the sampling distribution of a statistic, and in particular describe the behavior of the sample mean</li> </ol>



				5) Analyze the correlated data and fit the linear regression models.
15	PMC303	Computer Networks	<p>The course has been intended to impart knowledge in the domain of topology, data communication, protocols and data propagation issues in computer networks.</p> <p>The contents are descriptive to enforce knowledge of working of seven layers of network model, path finding issues, security and other communication paradigm.</p>	<ol style="list-style-type: none"> <li>1) Understand the functions and working of different networking devices</li> <li>2) Learn topology, data communications, protocol and data propagation issues in computer networks.</li> <li>3) Know the working of seven layer network model, TCP/IP, OSI etc.,</li> <li>4) To understand the different routing algorithms.</li> </ol>
16	PMC304	Mechanics	<p>This course is intended to provide a treatment of basic knowledge in mechanics used in deriving a range of important results and problems related to rigid bodies The objective is to provide the student the classical mechanics approach to solve a mechanical problem.</p>	<ol style="list-style-type: none"> <li>1) Understand the dynamics involving a single particle like projectile motion, Simple harmonic motion, pendulum motion and related problems.</li> <li>2) Study the path described by the particle moving under the influence of central force.</li> <li>3) Apply the concept of system of particle in finding moment inertia, directions of principle axes and consequently Euler's dynamical equations for studying rigid body motions.</li> <li>4) Represent the equation of motion for mechanical systems using the Lagrangian</li> </ol>

				<p>and Hamiltonian formulations of classical mechanics.</p> <p>5) Obtain canonical equations using different combinations of generating functions and subsequently developing Hamilton Jacobi method to solve equations of motion.</p>
17	PMC208	Operations Research	<p>Operations research helps in solving problems in different environments that needs decisions. This module aims to introduce students to use quantitative methods and techniques for effective decisions-making; model formulation and applications that are used in solving business decision problems.</p>	<ol style="list-style-type: none"> <li>1) Formulate some real life problems into Linear programming problem.</li> <li>2) Use the simplex method to find an optimal vector for the standard linear programming problem and the corresponding dual problem</li> <li>3) Prove the optimality condition for feasible vectors for Linear programming problem and Dual Linear programming problem.</li> <li>4) Find optimal solution of transportation problem and assignment problem</li> <li>5) Learn the constructions of networks of a project and optimal scheduling using CPM and PERT.</li> <li>6) Formulate and solution of linear programming model of two person zero sum game</li> <li>7) Solve nonlinear programming problems using Lagrange multiplier and using Kuhn-Tucker conditions</li> </ol>

18	PMC401	Functional Analysis	The main aim of this course is to introduce the students basic concepts of functional analysis to facilitate the study of advanced mathematical structures Banach spaces, Hillbert Spaces and operators.	<ol style="list-style-type: none"> <li>1) Understand the normed linear spaces, Banach space and Dual spaces</li> <li>2) Understand inner product spaces, orthogonality and Hillbert spaces.</li> <li>3) distinguish between finite and infinite dimensional spaces.</li> <li>4) apply linear operators in the formulation of differential and integral equations.</li> </ol>
19	PMC402	Algebra-II	The objective of this course is to introduce the students concepts of field and its several types of extensions, finite fields and Galois theory. Also to introduce the concepts of vector spaces, linear transformations and their different canonical forms.	<ol style="list-style-type: none"> <li>1) Understand the concepts of fields, extension of fields and splitting fields of polynomials.</li> <li>2) Understand properties of finite fields and Galois theory.</li> <li>3) Understand the concepts of vector spaces, basis, dimension and linear transformations.</li> <li>4) Find the metrics corresponding to linear transformation and different canonical forms like triangular and Jordan canonical form etc.</li> </ol>

**List of Elective Courses:**

<u>S. No.</u>	<u>Course No.</u>	<u>Course Name</u>	<u>Course Objectives</u>	<u>Course Learning Outcomes:</u>
				Upon completion of this course, the student will be able to:
1.	PMC311	Computer Graphics	The course develop student's knowledge and understanding in the fundamental principles of computer graphics, hardware system architecture for computer graphics, computer graphic algorithms such as geometric representation, scan conversion; and 2D and 3D objects' viewing and transformation The student will be able to understand the basic mathematical concepts related to computer graphics including linear algebra and geometry, graphics pipeline, frame buffers, and graphic accelerators/co-processors.	<ol style="list-style-type: none"> <li>1) Understand the basic mathematical models and algorithms related to geometric representation scan conversion and object viewing and transformation;</li> <li>2) Understand and recognize essential concepts, principles, theories, current and future development for computer graphics disciplines.</li> <li>3) Develop skill in image rendering using computer graphics technology</li> <li>4) Develop good understanding of various graphics algorithms and the trend of their use in various real-life systems</li> </ol>
2.	PMC312	Object Oriented Programming	The main objective of this course is to define and highlight the importance of object oriented programming. The	<ol style="list-style-type: none"> <li>1) Learn the fundamentals of object oriented programming using C++ programming language.</li> </ol>

			<p>students will see how to use concepts of object oriented programming in real-life using C++ programming language. The students will learn potential C++ features like overloading, type conversions, inheritance and will be beneficial for students and programmers who are stepping in software industries and the world of information technology.</p>	<ol style="list-style-type: none"> <li>2) Learn how OOP concepts like data abstraction, information hiding and code reusability are managed efficiently with C++.</li> <li>3) Evaluate and apply the concepts of inheritance and polymorphism among classes</li> <li>4) Explain the benefits of object oriented design and the types of systems in which it is an appropriate methodology.</li> </ol>
3.	PMC313	Graph Theory and Applications	<p>The objective of the course is to introduce students with the fundamental concepts in graph Theory, with a sense of some its modern applications. They will be able to use these methods in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.</p>	<ol style="list-style-type: none"> <li>1) Understand the basic concepts of graphs, directed graphs, and weighted graphs and able to present a graph by matrices.</li> <li>2) Understand the properties of trees and able to find a minimal spanning tree for a given weighted graph.</li> <li>3) Understand Eulerian and Hamiltonian graphs.</li> <li>4) Apply shortest path algorithm to solve Chinese Postman Problem .</li> <li>5) Apply the knowledge of graphs to solve the real life problem.</li> </ol>
4.	PMC314	Artificial Neural Networks	<p>This course shall help students in understanding the role</p>	<ol style="list-style-type: none"> <li>1) Appreciate the role of neural networks in</li> </ol>

			of neural networks in artificial intelligence and machine learning. Students shall get knowledge on different learning paradigms for neural networks and also on different neural network models.	<p>machine learning process.</p> <ol style="list-style-type: none"> <li>2) Learn the use of artificial neural networks in real life applications.</li> <li>3) Implement different artificial neural network models.</li> </ol>
5.	PMC315	Digital Image Processing	The objective of this course is to cover the basic theory and algorithms that are widely used in digital image processing, expose students to current technologies and issues that are specific to image processing systems and develop critical thinking about shortcomings of the state of the art in image processing.	<ol style="list-style-type: none"> <li>1) Understand the basic theory and algorithms that are widely used in digital image processing</li> <li>2) Understand the current technologies and issues that are specific to image processing systems.</li> <li>3) Develop image processing algorithms and their testing.</li> <li>4) Develop critical thinking about shortcomings of the state of the art in image processing</li> </ol>
6.	PMC317	Software Engineering	In this course, students will gain a broad understanding of the discipline of software engineering and its application to the development and management of software systems. The course will help students to learn the knowledge of basic SW engineering methods and practices, and	<ol style="list-style-type: none"> <li>1) Understand software process models and apply methods for Design and Development of software projects.</li> <li>2) Plan and deliver an effective software engineering process, based on knowledge of widely used development lifecycle models.</li> <li>3) Understand requirements analysis for software engineering problems.</li> </ol>

			<p>their appropriate application, to understand software process models, processes of requirements analysis thorough software design concepts, tools and techniques for software construction and maintenance. Students shall be able learn various techniques, metrics and strategies for testing software projects. To learn and apply standards, CASE tools and techniques</p>	<ol style="list-style-type: none"> <li>4) Understand thorough software design concepts, different software architectural styles and object oriented analysis and design using UML.</li> <li>5) Learn various fundamentals, tools and techniques for software construction and maintenance.</li> <li>6) Formulate a testing strategy for a software system, employing techniques such as unit testing, test driven development and functional testing.</li> </ol>
7.	PMC318	Design and Analysis of Algorithms	<p>The aim of this course is to introduce the concepts of algorithm analysis using time complexity. This course also provides the knowledge of algorithm design methodologies</p>	<ol style="list-style-type: none"> <li>1) Appreciate the requirements of algorithm analysis.</li> <li>2) Understand the concepts behind divide and conquer; greedy technique, backtracking and dynamic programming after going through this course.</li> <li>3) Understand the concept behind NP-completeness.</li> <li>4) Hands on experience in implementing these strategies on machine.</li> </ol>
8.	PMC319	Wavelets and Applications	<p>The objective of this course is to cover the basic theory of wavelets, multiresolution analysis, construction</p>	<ol style="list-style-type: none"> <li>1) Understand the properties of various scaling functions and their wavelets.</li> <li>2) Understand the properties of</li> </ol>

			of scaling functions, bases, frames and their applications in various scientific problems.	<p>multiresolution analysis.</p> <p>3) Construct the scaling functions using infinite product formula and iterative procedure.</p> <p>4) Implement wavelets in various problems like image compression, denoising <i>etc.</i></p>
9.	PMC323	Theory of Computation	The objective of the course is to introduce students the areas of computability and fundamental topics in Computer Science. The course also facilitates life-long learning experience in Computer Science by providing the students with foundational material that continues to be applicable even as the discipline rapidly evolves.	<p>1) Possess the skills of master regular languages and finite automata</p> <p>2) Possess the skills of master context-free languages, push-down automata and Turing recognizable languages.</p> <p>3) Exposed to a broad overview of the theoretical foundations of computer science.</p> <p>4) Familiar with thinking analytically and intuitively for problem-solving situations in related areas of theory in computer science.</p>
10.	PMC326	Wireless and Mobile Computing	The course has been introduced with an intention to provide knowledge of wireless communication, media requisites, challenges and a comparative analysis with wired networks. The contents groom a learner in the area of	<p>1) Learn wireless network standards</p> <p>2) Know the construction and working of wireless networks</p> <p>3) Compare and contrast wire and wireless networks</p> <p>4) Understand issues of data communication and channelization</p> <p>5) Appreciate concept of wireless technologies</p>



			cellular communication, concept of frequency, wireless standards and concept of wireless integration with traditional wired networks.	
11.	PMC325	Information and Network Security	Understanding of basic concepts , services, threats and principles in network security. Comprise and implement various cryptographic techniques. Implement protocols like SSL, SSH. Implementation of email security services, authentication services, web security services. Comprise security services and mechanisms in the network protocol stack. Firewall requirements and its configuration.	<ol style="list-style-type: none"> <li>1) Understand Security trends.</li> <li>2) Implement various cryptographic algorithms.</li> <li>3) Understand various mechanism to protect Operating System from threats</li> <li>4) Understand the various type of system attacks and their countermeasures.</li> <li>5) Configuration of firewalls</li> </ol>
12.	PMC411	Numerical Methods for Partial Differential Equations	This course deals with the mathematical theory of numerical methods especially finite difference and finite element methods used to solve partial differential equations (PDEs).In this course, students will study algorithms and methods to obtain	<ol style="list-style-type: none"> <li>1) Find numerical solutions of heat conduction diffusion equation in one and two space variables with the aid of Bendre Schmidt explicit scheme, Crank Nicholson scheme, Du-Fort and Frankel Scheme etc.</li> <li>2) Carry out the stability analysis and truncation error in various</li> </ol>

			<p>numerical results for different kind of physically important PDEs system like Laplace, Poisson, Heat and Wave equations. Student will study analysis and applications of finite difference methods and finite element methods for the numerical solutions of various elliptic, hyperbolic and parabolic PDEs.</p>	<p>aforementioned numerical schemes.</p> <ol style="list-style-type: none"> <li>3) Apply difference schemes in spherical and cylindrical coordinate systems in one dimension parabolic equations</li> <li>4) Calculate the numerical solution of hyperbolic equations of second order in one and two space variables with explicit and implicit methods and ADI method</li> <li>5) Approximate Laplace and biharmonic operators.</li> <li>6) Solve the Dirichlet, Neumann and mixed type problems with Laplace and Poisson equations in rectangular, circular and triangular regions.</li> </ol>
13.	PMC422	Fluid Mechanics	<p>This course is intended to provide a treatment of topics in fluid mechanics to a standard where the student will be able to apply the techniques used in deriving a range of important results and in research problems. The objective is to provide the student with knowledge of the fundamentals of fluid mechanics and an appreciation of their</p>	<ol style="list-style-type: none"> <li>1) Understand the basic principles of fluid mechanics, such as Lagrangian and Eulerian approach, conservation of mass etc..</li> <li>2) Use Euler and Bernoulli's equations and the conservation of mass to determine velocity and acceleration for incompressible and inviscid fluid.</li> <li>3) Understand the concept of rotational and irrotational flow, stream functions, velocity potential, sink, source, vortex etc.</li> </ol>

			application to real world problems.	<ul style="list-style-type: none"> <li>4) Analyse simple fluid flow problems (flow between parallel plates, flow through pipe etc.) with Navier - Stoke's equation of motion.</li> <li>5) Understand the phenomenon of flow separation and boundary layer theory.</li> </ul>
14.	PMC423	Algebraic Coding Theory	The objective of the course is to introduce basic topics of algebraic coding theory like error correction and detection, linear codes, Hamming codes, finite fields and BCH codes, dual codes and the weight distribution, cyclic codes, generator polynomial and check polynomial.	<ul style="list-style-type: none"> <li>1) Learn about basic techniques of algebraic coding theory like matrix encoding, polynomial encoding, and decoding by coset leaders etc.</li> <li>2) Different types of codes like linear, BCH, cyclic and MDS codes.</li> <li>3) Learn how algebraic coding theory is applicable in real world problems.</li> </ul>
15.	PMC424	Finite Element Methods	The objective of the course includes an introduction about different finite element methods in one-, two- and three-dimensions. The course focuses on analyzing variety of finite elements as per the requirements of solutions of differential equations.	<ul style="list-style-type: none"> <li>1) Formulate simple problems into finite elements.</li> <li>2) Solve the elasticity and the heat transfer problems.</li> <li>3) Solve the complicated two- and three-dimensional problems.</li> <li>4) Appreciate the importance of finite element methods for solving real life problems arising in various fields of science and engineering.</li> </ul>

16.	PMC301	Topology	This course aims to introduce the fundamentals of point set topology and the properties of different types of topological spaces.	<ol style="list-style-type: none"> <li>1) Understand to construct topological spaces from metric spaces and using general properties of neighborhoods, open sets, close sets, basis and sub-basis.</li> <li>2) Apply the properties of open sets, close sets, interior points, accumulation points and derived sets in deriving the proofs of various theorems.</li> <li>3) To understand the concepts of countable spaces and separable spaces.</li> <li>4) Understand the concepts and properties of the compact and connected topological spaces.</li> </ol>
17.	PMC426	Number Theory and Cryptography	The purpose of the course is to introduce classical number theory and to demonstrate applications of number theory (such as public-key encryption). Introduction of congruences, solution of congruence equations and system of equations with one and more variables including arithmetic functions and farey series will be done. Some exposures to	<ol style="list-style-type: none"> <li>1) Understand the properties of divisibility and prime numbers, compute the greatest common divisor and least common multiples and handle linear Diophantine equations.</li> <li>2) Understand the operations with congruences, linear and non-linear congruence equations</li> <li>3) Understand and use the theorems: Chinese Remainder Theorem, Lagrange theorem, Fermat's theorem, Wilson's theorem.</li> </ol>

			cryptography will also be given.	<ol style="list-style-type: none"> <li>4) Use arithmetic functions in areas of mathematics.</li> <li>5) Understand continue fractions and will be able to approximate reals by rationals,</li> <li>6) Understand the basics of RSA security and be able to break the simplest instances.</li> </ol>
18.	PMC427	Fuzzy Sets and Applications	The objective of this course is to teach the students the need of fuzzy sets, arithmetic operations on fuzzy sets, fuzzy relations, possibility theory, fuzzy logic, and its applications	<ol style="list-style-type: none"> <li>1) Construct the appropriate fuzzy numbers corresponding to uncertain and imprecise collected data.</li> <li>2) Handle the problems having uncertain and imprecise data.</li> <li>3) Find the optimal solution of mathematical programming problems having uncertain and imprecise data.</li> <li>4) Deal with the fuzzy logic problems in real world problems.</li> </ol>
19.	PMC432	Advanced Operations Research	The objective of this course is to teach the basic concepts of non-linear programming problems as well as the methods to solve quadratic programming problems, goal programming problems, multi-objective	<ol style="list-style-type: none"> <li>1) Understand the concept of convexity and generalized convexity.</li> <li>2) To derive the necessary conditions (KT conditions) for constrained nonlinear optimization problems.</li> <li>3) To solve quadratic, goal and multi-objective programming problems.</li> </ol>

			programming problems and search technique to find the solution of unconstrained optimization problems.	4) Use search technique to find the optimal solution of unconstrained optimization problems.
20.	PMC433	Theory of Elasticity	This course is intended to provide a basic treatment of the formulation of linear elasticity theory and its application to problems of stress and displacement analysis. The objective is to provide the student knowledge of fundamentals of theory of elasticity and an appreciation of their application to the different fields of research.	<ol style="list-style-type: none"> <li>1) Understand the notation and properties of different types of tensor.</li> <li>2) Learn various terms related to stress tensor like normal and shear stress, stress quadric of Cauchy, Principal stress and invariants.</li> <li>3) Learn affine transformations and geometrical interpretation of the components of strain and terms related to strain tensor.</li> <li>4) Understand the generalized Hooke's law, reduction of elastic constants to different elastic models from the most general case.</li> <li>5) Develop equilibrium and dynamical equations of an isotropic elastic solid.</li> <li>6) Learn some important aspects of wave propagation in the infinite and semi-infinite solids.</li> </ol>
21.	PMC430	Modeling of Stellar Structure	The goal of this course is to familiarize the students with the basic observed properties of stars and	<ol style="list-style-type: none"> <li>1) Understand the various properties of stars.</li> <li>2) Understand the basic physics and fundamental</li> </ol>

			to provide them the knowledge of basic physics and fundamental properties that govern stars and their structures. The aim of this course is also to understand mathematical techniques to solve the stellar structure equations and apply the basic theory of stellar structures on analytical models.	<p>properties that govern star and their structure.</p> <p>3) Learn the mathematical methods to solve stellar structure equations.</p> <p>4) Develop mathematical methods of stellar structures and their solution techniques.</p> <p>5) Study the various properties of super dense objects like white dwarf stars.</p>

The department also offers the following courses to undergraduate courses/postgraduate students of the institute

<u>S.No.</u>	<u>Course Code</u>	<u>Course Name</u>	<u>Course Outcome</u>	<u>Course Learning Outcome</u>
				Upon completion of this course, the students will be able to:
1	UMA003	Mathematics I	To provide students with skills and knowledge in sequence and series, advanced calculus and calculus of several variables which would enable them to devise solutions for given	<p>1) Apply the knowledge of calculus to plot graphs of functions and solve the problem of maxima and minima.</p> <p>2) Determine the convergence/divergence of infinite series,</p>

			situations they may encounter in their engineering profession	<p>approximation of functions using power and Taylor's series expansion and error estimation.</p> <p>3) Evaluate multiple integrals and their applications to engineering problems.</p> <p>4) Examine functions of several variables, define and compute partial derivatives, directional derivatives and their use in finding maxima and minima.</p> <p>4) Analyze some mathematical problems encountered in engineering applications.</p>
2	UMA004	Mathematics II	To introduce students the theory and concepts of differential equations, linear algebra, Laplace transformations and Fourier series which will equip them with adequate knowledge of mathematics to formulate and solve problems analytically.	<p>1) Solve the differential equations of first and 2nd order and basic application problems described by these equations.</p> <p>2) Find the Laplace transformations and inverse Laplace transformations for various functions. Using the concept of Laplace transform students will be able to solve the initial value and boundary value problems.</p> <p>3) Find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and wave equations.</p> <p>4) Solve systems of linear equations by using elementary row operations.</p> <p>5. Identify the vector</p>



				spaces/subspaces and to compute their bases/orthonormal bases. Further, students will be able to express linear transformation in terms of matrix and find the eigen values and eigen vectors.
3	UMA005	Introductory Mathematics I	The objective is to develop the basics of computing skills and application of quantitative and statistical operations required for biological studies.	<ol style="list-style-type: none"> <li>1) Acquire knowledge of basic algebra, trigonometry, matrices, coordinate geometry etc.</li> <li>2) Apply to solve geometric problems involving triangles etc.</li> <li>3) Analyze the properties of one or two dimensional geometric shapes (lines, circle)</li> <li>3) Able to solve system of linear equations algebraically (using matrices).</li> <li>4) Analyze the collected/observed data statistically to extract meaningful result.</li> </ol>
4	UMA006	Introductory Mathematics II	The objective is to develop the basics skills in calculus and differential equations and application of quantitative required for biological studies.	<ol style="list-style-type: none"> <li>1) Understand functions, related properties and determine their continuity and differentiability.</li> <li>2) Apply derivatives in graphing and maxima and minima of single variable function.</li> <li>3) Find integration of function using by parts, by substitution and partial fraction methods and apply these to find areas of bounded regions and rectifications.</li> </ol>

				4) Learn methods to solve first order ordinary differential equations and apply it to biological problems.
5	UMA007	Numerical Analysis	The main objective of this course is to motivate the students to understand and learn various numerical techniques to solve mathematical problems representing various engineering, physical and real life problems.	<ol style="list-style-type: none"> <li>1) Understand the errors, source of error and its effect on any numerical computations and also analysis the efficiency of any numerical algorithms.</li> <li>2) Learn how to obtain numerical solution of nonlinear equations using bisection, secant, Newton, and fixed-point iteration methods.</li> <li>3) Solve system of linear equations numerically using direct and iterative methods.</li> <li>4) Understand how to approximate the functions using interpolating polynomials.</li> <li>5) Learn how to solve definite integrals and initial value problems numerically.</li> </ol>
6	UMA031	Optimisation Techniques	The main objective of the course is to formulate mathematical models and to understand solution methods for real life optimal decision problems. The emphasis will be on basic study of linear programming problem, Integer programming problem, Transportation problem, Two person zero sum games with economic	<ol style="list-style-type: none"> <li>1) Formulate and solve linear programming problems.</li> <li>2) Solve the transportation and assignment problems</li> <li>3) Solve the Project Management problems using CPM</li> <li>4) Solve two person zero-sum games</li> </ol>

			applications and project management techniques using PERT and CPM.	
7	DMC007	Research Methodology	<p>The aim of this course is to motivate the students an intrinsic interest in statistical thinking and instil the belief that statistics is important for scientific research.</p>	<p>Upon the completion of this course, the student will be able to:</p> <ol style="list-style-type: none"> <li>1. learn how to analyze the data using different descriptive measures and present them graphically.</li> <li>2. compute the probabilities of events along with an understanding of the random variables, expectation and various probability distributions.</li> <li>3. understand the estimation of Normal distribution parameters and their one-sample and multi-sample hypothesis tests along with applications to real world problems.</li> <li>4. analyze the bivariate correlated data and fit the regression models along with measurement of different components of the time-series.</li> <li>5. learn the Markov processes with a study of stochastic process and their applications to real word problems.</li> </ol>
8	DMC013	Research Methodoy	<p>The aim of this course is to motivate the students an intrinsic interest in statistical</p>	<p>Upon the completion of this course, the student will be able to:</p>

			thinking and instil the belief that statistics is important for scientific research.	<ol style="list-style-type: none"> <li>1. learn how to analyze the data using different descriptive measures and present them graphically.</li> <li>2. compute the probabilities of events along with an understanding of the random variables, expectation and various probability distributions.</li> <li>3. understand the estimation of Normal distribution parameters and their one-sample and multi-sample hypothesis tests along with applications to real world problems.</li> <li>4. analyze the bivariate correlated data and fit the regression models along with measurement of different components of the time-series.</li> </ol>
9	PCL105	Statistical Methods and Algorithms	This course aims to shape the attitude of learners regarding the field of statistics and sampling and also instil the belief that statistics is important for scientific research.	<p>Upon the completion of this course, the students will be able to:</p> <ol style="list-style-type: none"> <li>1. compute the probabilities of composite events along with an understanding of the random variables.</li> <li>2. perform and interpret the various design of experiments and their implementation using different statistical software.</li> </ol>

				<p><b>3.</b> measure the different components of the time-series.</p> <p><b>4.</b> learn the Markov processes with a study of stochastic process, multivariate data and their applications to real word problems.</p>
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