FACULTY OF ENGINEERING

Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2019-2020)
(AICTE Model Curriculum for the Academic Year 2020-2021{III & IV Sem)

and

Syllabus

M.E. I to IV Semester

of

Two Year Post Graduate Degree Programme

in

Mechanical Engineering
Specialization in CAD/CAM

(With effect from the academic year 2019– 2020)
(As approved in the faculty meeting held on 25-06-2019)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2019

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Mechanical Engineering)I -Semester
Specialization in CAD/CAM

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration inHrs	
Theory Courses										
1	Core	Program Core – I	3	1	-	4	30	70	3	4
2	Core	Program Core – II	3	-	-	3	30	70	3	3
3	Elective	Professional Elective – I	3	-	-	3	30	70	3	3
4	Elective	Professional Elective – II	3	-	-	3	30	70	3	3
5	MC or OE	MLC/Open Elective	3	-	-	3	30	70	3	3
6	Audit	Audit Course – I	2	-	-	2	30	70	3	0
Practical/ Laboratory Courses										
7	Lab	Laboratory – I	-	-	2	2	25	50	3	1
8	Lab	Seminar	-	-	2	2	25	50	3	1
		Total	**17**	**01**	**04**	**21**	**230**	**520**		**18**

PC: Program Core **PE:**Professional Elective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:
1. Each contact hour is a Clock Hour.
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
3. ** Open Elective Subject is not offered to the students of Civil Engineering Department.

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Mechanical Engineering) II - Semester
Specialization in CAD/CAM

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Core	Program Core – III	3	1	-	4	30	70	3	4
2	Core	Program Core – IV	3	1	-	3	30	70	3	4
3	Elective	Professional Elective – III	3	-	-	3	30	70	3	3
4	MC or OE	Open Elective/MLC	3	-	-	3	30	70	3	3
5	Audit	Audit Course – II	2	-	-	2	30	70	3	0
Practical/ Laboratory Courses										
6	Lab	Laboratory – II	-	-	2	2	25	50	3	1
7	Lab	Laboratory – III	-	-	2	2	25	50	3	1
8	PC 1155 CD	Mini Project with Seminar	-	-	4	4	25	50	3	2
		Total	**14**	**02**	**08**	**24**	**300**	**450**		**18**

PC: Program Core **PE:**Professional Elective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:
1. Each contact hour is a Clock Hour.
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
3. ** Open Elective Subject is not offered to the students of Civil Engineering Department.

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Mechanical Engineering) III - Semester
Specialization in CAD/CAM

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Elective	Professional Elective – IV	3	-	-	3	30	70	3	3
2	Elective	Professional Elective – V	3	-	-	3	30	70	3	3
3	PC 1156 CD	Major Project Phase – I	-	-	20	20	100	-	3	10
		Total	**06**	**-**	**20**	**26**	**160**	**140**		**16**

M.E. (Mechanical Engineering) IV - Semester
Specialization in CAD/CAM

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PC 1157 CD	Major Project Phase – II (Dissertation)	-	-	32	32	-	200	3	16
		Total	**-**	**-**	**32**	**32**	**-**	**200**		**16**

PC: Program Core **PE:**Professional Elective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a Clock Hour
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
3. ** Open Elective Subject is not offered to the students of Civil Engineering Department.
4. The students who are willing to register for MOOCs in the M.E. (ME) III – semester instead of Professional Electives – IV & V, should register for those of the courses, approved by the CBoS, OU and respective college MOOCs Coordinator. Those students are strictly not permitted to appear for either CIE or SEE of Professional Electives – IV & V if they abstain from attending the semester classwork. Further, for students willing to appear for both MOOCS and Professional Electives, they should fulfil the minimum attendance criteria.

List of subjects of Professional Core

S. No.	Course Code	Course Title
1	PC 5101 CD	Computer Aided Modelling and Design
2	PC 5102 CD	Computer Integrated Manufacturing
3	PC 5103 CD	Computer Aided Mechanical Design and Analysis
4	PC 5104 CD	Finite Element Techniques

List of subjects of Professional Electives I to V

S. No.	Course Code	Course Title
1	PE 5116 CD	Product Design and Process Planning
2	PE 5117 CD	Design for Manufacture
3	PE 5118 CD	Mechanics of Composite Materials
4	PE 5119 CD	Optimization Techniques
5	PE 5120 CD	Design of Press Tools
6	PE 5121 CD	Additive Manufacturing Technologies and Applications
7	PE 5122 CD	Fracture Mechanics
8	PE 5123 CD	Experimental Techniques and Data Analysis
9	PE 5124 CD	Vibration Analysis and Condition Monitoring
10	PE 5125 CD	Computational Fluid Dynamics
11	PE 5126 CD	Robotic Engineering
12	PE 5127 CD	Advanced Metrology
13	PE 5128 CD	Control of Dynamic Systems
14	PE 5129 CD	Advanced Materials Technology
15	PE 5130 CD	Failure Analysis and Design

List of Mandatory Courses

S. No.	Course Code	Course Title
1	MC5121ME	Research Methodology & IPR

List of Open Electives

S. No.	Course Code	Course Title
1	OE9101CE**	Cost Management of Engineering Projects
2	OE9102CS	Business Analytics
3	OE9103EC	Embedded System Design
4	OE9104EE	Waste to Energy
5	OE9105ME	Industrial Safety

Note: ** Open Elective Subject is not offered to the students of Civil Engineering Department.

List of subjects of Audit Course-I

S. No.	Course Code	Course Title
1	AD 9001 HS	English for Research Paper Writing
2	AD 9002 CE	Disaster Management
3	AD 9003 HS	Sanskrit for Technical Knowledge
4	AD 9004 HS	Value Education

List of subjects of Audit Course-II

S. No.	Course Code	Course Title
1	AD 9011 HS	Constitution of India and Fundamental Rights
2	AD 9012 HS	Pedagogy Studies
3	AD 9013 HS	Stress Management by Yoga
4	AD 9014 HS	Personality Development through life Enlightenment Skills

List of Laboratory Courses

S. No.	Course Code	Course Title
1	PC 5151 CD	Advanced CAD Lab
2	PC 5152 CD	CAM and Automation Lab
3	PC 5153 CD	Computational Lab
4	PC 5154 CD	Advanced CAE Lab

Course Code	Course Title						Core/Elective
PC 5101 CD	**Computer Aided Modelling and Design**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- To study about the design process and concept of geometric transformations
- To study the concepts of wireframe modelling
- To study the concepts related to surface modelling
- To study the concepts of solid modelling
- To study about advanced modelling techniques, data exchange formats and mechanical tolerancing

Course Outcomes

At the end of this course, students will be able to

1. Understand the design process and analyze the modeling concepts and its graphics using transformations
2. Analyze the utility and application of wire frame modelling
3. Understand the concepts of surface modelling
4. Apply the concepts of solid modeling techniques in practical software's
5. Understand the various advanced modeling concepts and analyze the utility of data exchange formats

UNIT-I

Introduction to CAD: Criteria for selection of CAD workstations, Shigle Design Process, Design criteria, Geometric modeling, entities, 2D & 3D Primitives. 2D & 3D Geometric Transformations: Translation, Scaling, Rotation, Reflection and Shearing, concatenation.

UNIT-II

Wire frame modeling: Curves: Curve representation. Analytic curves – lines, Circles, Ellipse, Conis. Synthetic curves – Cubic, Bezier, B-Spline, NURBS.

UNIT-III

Surface Modeling: Surface entities, Surface Representation. Analytic Surface – Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cylinder. Synthetic Surface-Cubic, Bezier, B-spline, Coons.

UNIT-IV

Solid Modeling Techniques: Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration, Boundary Representation (B-rep) & Constructive Solid Geometry (CSG).

UNIT-V

Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioural Modeling, Conceptual Design & Top Down Design.

Data exchange formats: IGES, PDES, STL, STEP.

Dimensioning and tolerances: Linear, angular, angular dimensions, maximum material condition (MMC), Least material condition (LMC).Geometric tolerances and Surface finish.

Suggested Reading:

1. Ibrahim Zeid, CAD/CAM, Theory and Practice, McGraw Hill, 1998.

2. Foley, Van Dam, Feiner and Hughes, Computer Graphics Principles and Practice, 2nd Ed., Addison – Wesley, 2000.
3. Martenson, E. Micheal, Geometric Modelling, John Wiley & Sons, 1995.
4. Hill Jr, F.S., Computer Graphics using open GL, Pearson Education, 2003.
5. P.N. Reddy, Taj Reddy and C. Srinivas Rao, Production Drawing Practice, The HI-TECH Publishers,2002.

Course Code	Course Title						Core/Elective
PC 5102 CD	**Computer Integrated Manufacturing**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study about types of manufacturing and engineering concepts w.r.t manufacturing
- To study the concepts of CIM database and its management
- To study the various automation production lines
- To study about CIM models
- To study the advancements in the manufacturing systems

Course Outcomes

At the end of this course, students will be able to

1. Understand the need for CIM, evolution of CIM, fundamentals of CIM and the Concept of Concurrent Engineering.
2. Know the role of database management of CIM and understand various types of CIM technologies.
3. Understand the fundamental networking concepts that helps in integrating all the important components of an enterprise and discusses the different types of CIM models developed by various industries.
4. Understand the new trends in manufacturing systems.

UNIT – I

Introduction to CIM: The meaning of Manufacturing, Types of Manufacturing; Basic Concepts of CIM: CIM Definition, Elements of CIM, CIM wheel, concept of technology, Evolution of CIM, Benefits of CIM, Needs of CIM: Hardware and software. Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering, Framework for integration of Life-cycle phases in CE, Concurrent Engineering Techniques, Integrated Product Development(IPD), Product Life-Cycle Management (PLM), Collaborative Product Development.

UNIT – II

CIM database and database management systems: Introduction, Manufacturing Data: Types, sources; Database Terminology, Database requirements, Database models, Database Management System, DBMS Architecture, Query Language, Structural Query Language (SQL): Basic structure, Data definition Language (Create, Alter, Drop, Truncate, View), Data Manipulation Language (store, retrieve, update, delete). Illustration of Creating and Manipulating a Manufacturing Database. SQL as a Knowledge Base Query Language. Features of commercial DBMS: Oracle, MySQL, SQL Access, Sybase, DB2. Product Data Management (PDM), Advantages of PDM.

UNIT – III

Automation Production Lines: Automated Flow lines, Methods of Workpart Transport, Transfer Mechanism, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations.

Analysis of Automated Flow Lines: General Terminology and Analysis, analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.

UNIT –IV

Enterprise Wide Integration in CIM and CIM Models: Introduction to Networking, Principles of Networking, Network Terminology, Types of Networks: LAN, MAN, WAN; Selection of Network Technology: Communication medium, Network Topology, Medium access control Methods, Signaling methods; Network Architectures and Protocols: OSI Model, MAP & TOP, TCP/IP, Network Interconnection and Devices, Network Performance. Framework for Enterprise-wide Integration. CIM Models: ESPRIT-CIM OSA Model, NIST-AMRF Model, Siemens Model of CIM, Digital Equipment Corporation Model, IBM Concept of CIM.

UNIT – V

Future Trends in Manufacturing Systems: Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste to Profit, Four Functions of Lean Production, Performance Measures, The Supply Chain, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems.

Suggested Reading:

1. S. Kant Vajpayee: Principles of Computer Integrated Manufacturing, Printice-Hall India.
2. Nanua Singh: Systems Approach to Computer Integrated Design and Manufacturing- John Wiley.
3. P. Radhakrishnan, S. Subramanyam: CAD/CAM/CIM, New Age International
4. Alavudeen, Venkateshwaran: Computer Integrated Manufacturing, Printice-Hall India
5. MikellP.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia.

Course Code	Course Title						Core/Elective
PC 5103 CD	**Computer Aided Mechanical Design and Analysis**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- To develop students knowledge and understanding of Bending of Plates
- To understand the basics of designing pressure vessels against internal and external pressure loads.
- To understand the effect of thermal stress on pressure vessel
- To understand the phenomenon of buckling in pressure vessels and usage of various methods available to prevent buckling of pressure vessels
- To understand the importance of numerical methods in solving multi degree freedom dynamic analysis problems
- To understand various numerical methods available for solving eigen values problems

Course Outcomes

At the end of this course, students will be able to

1. Determine the stresses in the plates due to various types of stresses
2. Design the pressure vessels for different applications
3. Design vessels/ cylinders to prevent the buckling failure
4. Determine the vibrations in stepped beams and bars
5. Analyze the stability of the system

UNIT-I

Stresses in flat plates: Introduction, Bending of plate in one direction, Bending of plate in two perpendicular directions, Thermal stresses in plates, Bending of circular plates of constant thickness, Bending of uniformly loaded plates of constant thickness.

UNIT-II

Design of pressure Vessels: Introduction and constructional features of pressure vessels, stresses in pressure vessels, shrink fit stresses in built up cylinders, autofrettage of thick cylinders, thermal stresses and their significance. Stress concentration at a variable thickness, thickness transition in a cylindrical vessel, about a circular hole, elliptical openings, reinforcement design

UNIT-III

Buckling in vessels: Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT-IV

Eigen Value Problems: Properties of Eigen values and Eigen Vectors, Torsional, Longitudinal vibration, lateral vibration, Sturm sequence. Subspace iteration and Lanczo‘s method, Component mode synthesis, Eigen value problems applied to stepped beams and bars.

UNIT-V

Dynamic Analysis: Direct integration method, Central difference method, Wilson-θ method, Newmark method, Mode superposition, Single degree of freedom system response, Multi degree of freedom system response, Rayleigh damping, Condition for stability.

Suggested Reading:

1. John, V. Harvey, Pressure Vessel Design: Nuclear and Chemical Applications, Affiliated East West Press Pvt. Ltd., 1969.
2. V. Rammurti, Computer Aided Mechanical Design and Analysis, Tata McGraw Hill-1992.
3. Abdel-RehmanRagab& Salah EdinBayoumi, Engineering Solid Mechanics, CRC Press, 1998
4. Annaratone, Donatello,Pressure Vessel Design, springer verlag, 2007
5. Henry bednar, Pressure vessel Design handbook, Krieger Pub Co; 2 edition.
6. Chandrasekhra, Theory of Plates, University Press, 2001

Course Code	Course Title						Core/Elective
PC 5104 CD	**Finite Element Techniques**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- To understand the theory and application of the finite element method for analyzing structural systems
- To learn Approximation theory for structural problems as the basis for finite element methods
- To learn formulations for a variety of elements in one, two and three dimensions
- To understand modeling and analysis of structures using planar, solid, and plate elements

Course Outcomes

At the end of this course, students will be able to

1. Determine the shape functions and stiffness matrices and finite element equations
2. Analyze the behavior of the trusses and frames
3. Analyze complex structural problems
4. Analyze the thermal behavior of different systems
5. Determine the dynamic behavior of the systems

UNIT-I

Introduction: Finite Element Method of solving field problems. Stress and Equilibrium. Boundaryconditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Problem: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach: Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions.

UNIT-II

Analysis of trusses and frames: Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element.

UNIT-III

Finite element modelingof two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four nodedisoparametric elements and numerical integration. Finite element modeling of Axisymmentric solids subjected of axisymmetric loading with triangular elements. Convergence requirements and geometric isotropy.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod.

Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors. Analysis of a uniform shaft subjected to torsion using Finite Element Analysis.

UNIT-V

Finite element formulation of three dimensional problems in stress analysis. Finite Element formulation of an incompressible fluid. Potential flow problems Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Suggested Reading:

1. Tirupathi R Chandraputla and Ashok. D. Belegundu, *Introduction of Finite Element in Engineering,*Prentice Hall of India, 1997.
2. Rao S.S., *The Finite Element Methods in Engineering,* Pergamon Press, 1989.
3. Segerland. L.J., *Applied Finite Element Analysis,* Wiley Publication, 1984.
4. Reddy J.N., *An Introduction to Finite Element Methods,* McGraw Hill Company, 1984.

Course Code	Course Title						Core/Elective
PE 5116 CD	**Product Design and Process Planning**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To learn the essential factors with innovative ideas to develop successive right product.
- To know the product reliability, copyrights, value Engineering in product design and cost estimation of product.
- To understand the various machining processes, improving tolerances methods, selection of materials and their importance.
- To understand the modern approaches, ergonomics considerations in product design, integration of design, manufacturing and production control.

Course Outcomes

At the end of this course, students will be able to

1. Understand the functions related to the product design and process design
2. Estimate the product reliability
3. Determine the manufacturing process based on the application
4. Design as per the industrial ergonomics
5. Utilize the computers for the management of the manufacturing process

UNIT-I

Product design and process design functions, selection of a right product, essential factors of product design, Morphology of design, sources of new ideas for products, evaluation of new product ideas. Product innovation procedure-Flow chart. Qualifications of product design Engineer. Criteria for success/failure of a product. Value of appearance, colours and Laws of appearance.

UNIT-II

Product reliability, Mortality Curve, Reliability systems, Manufacturing reliability and quality control. Patents: Definitions, classes of patents, applying for patents. Trademarks and copyrights. Cost and quality sensitivity of products, Elements of cost of a product, costing methods, cost reduction and cost control activities. Economic analysis, Break even analysis Charts. Value engineering in product design, creativity aspects and techniques. Procedures of value analysis – cost reduction, material and process selection.

UNIT-III

Various manufacturing processes, degree of accuracy and finish obtainable, process capability studies. Methods of improving tolerances. Basic product design rules for Casting, Forging, Machining, Sheet metal and Welding. Physical properties of engineering materials and their importance on products. Selection of plastics, rubber and ceramics for product design.

UNIT-IV

Industrial ergonomics: Man- machine considerations, ease of maintenance. Ergonomic onsiderations in product design-Anthropometry Design of controls, man-machine information exchange. Process sheet detail and their importance, advanced techniques for higher productivity. Just -in -time and Kanban System. Modern approaches to product design; quality function development, Rapid prototyping.

UNIT-V

Role of computer in product design and management of manufacturing, creation of manufacturing data base, Computer Integrated Manufacturing, communication network, production flow analysis, Group Technology, Computer Aided product design and process planning. Integrating product design, manufacture and production control.

Suggested Reading:

1. Niebel, B.W., and Draper, A.B., Product design and process Engineering, McGraw Hill Kogalkusha Ltd., Tokyo, 1974.
2. Chitale, A.K, and Gupta, R.C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Mahajan, M. Industrial Engineering and Production Management, DhanpathRai& Co., 2000.

Course Code	Course Title						Core/Elective
PE 5117 CD	**Design for Manufacture**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study about the general design principles for manufacturability
- To study process of metallic components design
- To study process of providing various shapes in metallic components design
- To study process of non metallic components design
- To study process related to assembly of components

Course Outcomes

At the end of this course, students will be able to

1. Determine the economic use of the raw materials
2. Understand the various secondary manufacturing aspects
3. Understand the underlying principles in creating various shapes in metallic components
4. Determine the principles involved in non metallic components design
5. Analyze the economical assemblage process with the aid of computers

UNIT-I

Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization. Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.

UNIT-II

Metallic Components Design: Metal extrusion, metal stamping, fine blanking, four slide parts, spring and wire forms, spun metal parts, cold headed parts, extruded parts, tube and section bends, rolled formed parts, power metal parts, forging electro forming parts, specialized forming methods, turned parts, machined round holes, drilled parts, milled parts.

UNIT-III

Metallic Components Design: Planned shaped and slotted parts, screw threaded contoured and internal ground parts, center less ground, electrical discharged, rolled furnished parts, electro chemical and advanced machine parts. Sand cast, die cast, investment cast and other cast products.

UNIT-IV

Non Metallic Components Design: Thermosetting plastic, injection moulded and rotational moulded parts, blow moulded, welded plastic articles, ceramics. Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, bearing assembly.

UNIT-V

Assembled Parts Design: Retension, bolted connection, screwed connections, flanged connections, centred connections, press fitted connections, surface finishing, plated parts, heat treated parts, NC machining, group technology, low cost automation, computer aided manufacture, product design requirements. **Case Studies:** Identification of economical design and redesign for manufacture.

Suggested Reading:

1. James G. Bralla, ―*Hand book of product design for manufacturing*‖ McGraw Hill Co., 1986
2. K.G. Swift ―*Knowledge based design for Manufacture*‖, Kogan page Limited, 1987.

Course Code	Course Title						Core/Elective
PE 5118 CD	**Mechanics of Composite Materials**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study about the types of composites
- To study the properties of composites
- To study the laminar structure of composites and determine the stresses
- To study the strength and failure modes in composites
- To study the analysis of plates

Course Outcomes:

At the end of this course, students will be able to

1. Understand the importance of fibres and matrix materials in preparation of various types of composites
2. Determine the micromechanics of composites
3. Determine the behavior of composite beams
4. Understand the behavior of unidirectional fibre composites and orthotropic lamina composites
5. Analyze the stresses in plates and cylindrical shells

UNIT-I

Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites carbon fibre composites.

UNIT-II

Micromechanics of Composites: Mechanical properties-Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties-Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

UNIT-III

Macromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.

UNIT-IV

Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites

Fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de-lamination failure, fatigue of laminate composites. Effect of variability of fibre strength.

Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.

UNIT-V

Analysis of plates and shells: Plate equilibrium equations, Bending of composite plates, Levy and Navier solution for plates of composite materials. Analysis of composite cylindrical shells under axially symmetric loads.

Suggested Reading:

1. Jones, R.M., *Mechanics of Composite Materials, McGraw Hill Co., 1967.*
2. Calcote, L.R., *The Analysis of Laminated Composite Structures,* Van Nostrand, 1969.
3. Whitney, I.M. Daniel, R.B. Pipes, *Experimental Mechanics of Fibre Reinforced Composite Materials,* Prentice Hall, 1984.
4. Hyer, M.W., *Stress Analysis of Fibre Reinforced Composite Materials,* McGraw Hill Co., 1998.
5. Carl. T. Herakovich, *Mechanics of Fibrous Composites,* John Wiley Sons Inc., 1998.

Course Code	Course Title						Core/Elective
PE 5119 CD	**Optimization Techniques**						**Elective**
	Contact Hours per Week						
Prerequisite	L	T	D	P	CIE	SEE	Credits
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study about the design types of simulation
- To study about decision theory
- To study about integer programming
- To study about dynamic programming
- To study about classical optimization

Course Outcomes

At the end of this course, students will be able to

1. Determine the simulation process required for various applications
2. Analyze the decision making under certainty and uncertainty, risk etc.
3. Utilize the different methods of integer programming
4. Utilize the skills of dynamic programming for different types of problems
5. Analyze and apply the optimization techniques

UNIT-I

Simulation: Introduction, Types of Simulation, Simulation Models, Monte Carlo Simulation, Random Number, Pseudo Random Number, Mid-Square Method of generating Random Numbers, Application & Limitation, Application of Simulation to Inventory Control and Queuing Problem

UNIT-II

Decision Theory: Introduction, Decision, Decision Making & Decision Theory, Types of Decisions, decision making process, Types of Decision making Environment: **Decision making under certainty** – Expected Monetary Value (EMV), Expected Opportunity Loss (EOL) Criterion & Expected Value of Perfect Information (EVPI) Criterion **Decision making under risk**- Criterion of Pessimism or Manimax, Criterion of Optimism or Maximin, Minimax Regret Criterion, Criterion of Realism & Criterion of Rationality **Decision making under uncertainty** and **Decision tree analysis**: Introduction, Procedure of Constructing Decision Trees & Solution through Decision Tree Analysis.

UNIT-III

Integer Programming: Introduction, Types of Integer Programming Problems, Gomory‟s Cutting Plane method. Branch and Bound method for all Integer Programming Problems & Mixed Integer Programming Problems

UNIT-IV

Dynamic Programming: Introduction- Bellman‟s principle of optimality-Application of dynamic programming-Linear programming problem-Capital budgeting problem

UNIT-V

Classical Optimization: Introduction; Unconstrained problems of maxima and minima, constrained problems of maxima and minima; Constraints in the form of equations – Lagrangian method; Constraints in the form of inequalities -Kuhn-tucker conditions.

Suggested Reading:

1. S.S.Rao, Optimization Theory and Applications, NAI Publishers, Hyderabad, 1995.
2. S.D.Sharma, Operations Research, Kedarnath and Co. Publishers, Meerut, 2004.
3. V. K. Kapoor, Operations Research, S. Chand, New Delhi, 2004.
4. HamdyA.Taha, Operations Research, Pearson Education, New York, 2001.
5. Bronson-Schaum Series, Operations Research, McGraw Hill, Singapore, 1983.
6. David Goldberg, Genetic Algorithms, S Chand Publications, 2006.

Course Code	Course Title						Core/Elective
PE 5120 CD	**Design of Press Tools**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study the classification of presses
- To study the different components of the press tools
- To study about the various types of operations of press tools
- To study about bending in dies
- To study about drawing and forming operations

Course Outcomes

At the end of this course, students will be able to

1. Understand the various press tool operations and analyze the forces involved in it
2. Analyze the design of die plates, punches etc.
3. Analyze the various aspects in the design of dies
4. Determine the construction and working principles of dies based on application
5. Design and analyze the drawing and forming operations for practical application problems

UNIT-I

Classification of presses – Specification of Presses – Safety Devices in Presses – Principles of loading and unloading equipment – Various press tool operations – Selection of types of presses – Theory of shearing – Clearance concept – Location of clearance for regular and irregular shapes – Analysis of forces – Force, power & energy – Stock strip terms – Layouts – Economic utilization – Dimensioning of punches and die openings with tolerance.

UNIT-II

Classification of dies viz. shearing, bending, drawing & forming – Terminology of press tool elements – Design considerations of various elements viz. die plates, stock guides, strippers & types – Shedders – Stops - function and types – Pilots - function and types – Punches types – Punches mounted in punch holder – Calculation of spring, rubber, ejector – Shear and its application – Types of shear (cutting with inclined edges) – Alignment system design of press tools.

UNIT-III

Design of dies – Simple piercing/blanking – Inverted die – Compound die – Progressive dies – Rules for developing stock – Strip layouts for progressive dies – Types of progressive dies viz. blank through, slug cur-off and shear cut off – Load centre – Necessity – Analytical and graphical method to determine load centre (i.e. centre of pressure) – Miscellaneous dies – Shaving, Horn, Cam actuated and precision lamination dies – Fine blanking dies – Principles - design considerations.

UNIT-IV

Bending dies – Theory of bending – Blank development – Spring back effect – Spring back factor – Methods of correction to overcome spring back – both practical and theoretical – Types of bending dies viz. V, U and L – Pressure pad dies – Forces in bending – Construction and working principles – Press brake Tooling – Curling – Flanging – Principles of stretch forming – Stretch forming dies.

UNIT-V

Drawing and forming: Definition of drawing, redrawing, reverse redraw – Theory of drawing for metal flow in cylindrical shells – Blank development – Algebraic - centre of gravity, segment area and layout method – Severity of draw – Reduction – Strain factor – Draw force calculation – Draw die edge radius consideration – Blank holder – Stages in draw dies – Calculations – Drawing of rectangular components – Blank development – Draw beeds – Ironing – Defects in draw – Modern metal forming techniques viz. rubber pad forming, explosive forming, magnetic pulse forming, roll forming – Awareness of various software for sheet metal operations, both for analysis and design.

Suggested Reading:

1. Fundamentals of Tool Design – ASTME, Prentice Hall, New Delhi, 1987
2. Die Design Handbook – AISME, McGraw Hills, Newyork, 1965
3. Eary& Reed, Shear Working of Metals, Prentice Hall, New Delhi, 1969
4. Basic Die Making & Advance Die Making – D. Eugene Ostergaard, McGraw Hill
5. Tool Design by Cyril Donaldson – Tata McGraw Hill, New Delhi.

Course Code	Course Title						Core/Elective
PE 5121 CD	**Additive Manufacturing Technologies and Applications**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the fundamentals for additive manufacturing and how it is different and discuss about various types of liquid based, solid based and powder based AM technologies.
- To understand the various types of Pre-processing, processing, post-processing errors in AM. Also to know the various types of data formats and software's used in AM.
- To know the various applications of AM in design analysis, aerospace, automotive, biomedical and other fields

Course Outcomes

At the end of this course, students will be able to

1. Understand the fundamentals of prototyping and automated processes
2. Analyze the utility and application of liquid and solid based AM systems
3. Understand the concepts of powder based AM systems and Rapid tooling
4. Utilize the AM software's and Data formats
5. Utilize the AM for various practical applications

UNIT-I

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

UNIT-II

Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Polyjet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Microfabrication.

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT-III

Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting,Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT-IV

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques.

AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

UNIT-V

AM Applications: Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customised Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visulization of Biomolecules. Web Based Rapid Prototyping Systems.

Suggested Reading:

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific Publications, Third Edition, 2010.
2. Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer , 2001
3. Wholers Report 2000 – Terry Wohlers, Wohlers Associates, 2000
4. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.

Course Code	Course Title						Core/Elective
PE 5122 CD	**Fracture Mechanics**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study about the types of failure
- To study the concepts of elastic crack
- To study the concepts related to crack growth rate and its failure
- To study about elactic –plastic fracture
- To study about crack growth law

Course Outcomes

At the end of this course, students will be able to

1. Understand the concepts of fracture
2. Analyze the effect of crack size and its growth on the failure of the component
3. Understand the mechanics related to energy release rate in crack propagation
4. Determine the elastic plastic fracture mechanics
5. Determine the suitable materials for the application so as to avoid fracture

UNIT-I

Introduction: Crack in a Structure – Griffth Criterion – Cleavage fracture – Ductile fracture – Fatigue Cracking. Service failure analysis.

UNIT-II

Elastic Crack: Elastic Crack tip stress field – Solution to crack problems. Effect of finite size stress intensity factor – Special cases – Irwin plastic zone correction. Actual shape of plastic zone – Plane stress – Plane strain.

UNIT-III

Energy Principle: Energy release rate – Criterion for crack growth – Crack resistance curve – Principles of crack arrest – Crack arrest in practice. Fatigue Crack Growth: Fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor – Variable amplitude service loading, retardation model.

UNIT-IV

Elastic Plastic Fracture Mechanics: Elastic plastic fracture concept – Crack tip opening displacement – Jintegral technique; Determination of J-using FEM.

UNIT-V

Application of Fracture Mechanics: Fracture design – Selection of materials – fatigue crack growth rate curve – Stress intensity factor range – Use of crack growth law.

Suggested Reading:

1. Broek, D., Elementary Engineering Fracture Mechanics, Springer Science & Business Media, 2012.
2. John M. Barson and Stanely T. Rolfe, Fracture and Fatigue Control in Structures, Prentice Hall, 1987.
3. Jean Cemative and Jean Louis Chboche, Mechanics of Solid Materials, Cambridge University Press, 1987.

Course Code	Course Title						Core/Elective
PE 5123 CD	**Experimental Techniques and Data Analysis**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the working principle of instruments used for cutting forces measurement and temperature measurement.
- To have knowledge of various precision measuring instruments for metallurgical studies.
- To understand the basic concept of experiment design for collection of data
- To learn the data analysis, optimization of experimental methods for better data.

Course Outcomes

At the end of this course, students will be able to

1. Determine the cutting forces, displacement and stresses
2. Utilize the various techniques for the measurement of temperature
3. Analyze the microstructure using various techniques
4. Design the experiment and analyze the data
5. Determine the optimization of the experiments and its data

UNIT-I

Measurement of Cutting Forces: Strain gauge and piezoelectric transducers and their characteristics. Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and strain measurements by photoelasticity. Holography, interferometer, Moir techniques, strain gauge rosettes.

UNIT-II

Temperature Measurement: Circuits and instrumentation for different transducers viz, bimetallic, expanding fluid, electrical resistance, thermister, thermocouples, pyrometers. Flow Measurement: Transducers for flow measurements of Non-compressible and compressible fluids. Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, LaserDopler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schlieren photography. Interferometer.

UNIT-III

Metallurgical Studies: Optical and electron microscopy, X-Ray diffraction, Bragg‟s Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, electron microprobe. Surface Measurements: Micro hardness, roughness, accuracy of dimensions and forms. 3 -D co-ordinate measuring machines.

UNIT-IV

Experiment design & data analysis: Statistical methods, Randomized block design, Latin and orthogonal squares, factorial design. Replication and randomization. Data Analysis: Deterministic and random data, uncertainty analysis, tests for significance: Chi -square, student's t-test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling.

UNIT-V

Taguchi Methods: Experiment design and planning with Orthogonal arrays and linear graphs. Additive cause effect model. Optimization of response level. Identification of Design and noise factors.

Performance evaluation and Optimization by signal to noise ratios. Concept of loss function and its application.

Suggested Reading:

1. Holman, J.P.: Experimental Methods for Engineers, McGraw Hill Int., New York.
2. Venkatesh, V.C., and Chandrasekharan, Experimental Methods in Metal Cutting, Prentice Hall of India, Delhi.
3. Davis, O.V.; The Design and Analysis of Industrial Experiments, Longman, London.
4. Box and Jenkins; Time Series analysis, Forecasting and control, Holden Day, Sanfrancisco.
5. Dove and Adams, Experimental stress analysis and motion measurement, Prentice Hall of India, Delhi.
6. Tapan P. Bagchi, Taguchi Methods Explained, Prentice Hall of India, Delhi.

Course Code	Course Title						Core/Elective
PE 5124 CD	**Vibration Analysis and Condition Monitoring**						**Elective**
	Contact Hours per Week						
Prerequisite	L	T	D	P	CIE	SEE	Credits
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Fully understand importance of vibrations in mechanical design of machine parts that operate under vibratory conditions.
- Able to write differential equation of motion of vibratory system and understand free and forced modes of vibration
- Able to obtain linear vibratory models of dynamic systems of varying complexity (SDOF,MDOF)
- Able to understand the various condition monitoring techniques available in the literature
- Able to understand the various devices available to record interpret and understand the vibration data.

Course Outcomes

At the end of this course, students will be able to

1. Understand the causes of vibration and types of vibration
2. Determine the behavior of two degrees freedom systems
3. Analyze the multi degree freedom systems
4. Determine the methods that can be utilize for condition monitoring of various systems
5. Understand the various special vibration measuring techniques

UNIT-I

Causes and effects of vibration. Vibrations of Single Degree of freedom systems. Free, Damped and Forced vibrations

UNIT-II

Two Degree of freedom systems. Bending vibrations of two degree of freedom systems, Steady state and transient characteristics of vibration, vibration absorber and vibration isolation.

UNIT-III

Multi degree of freedom systems: Dunkerley method, Rayleigh method, stodola method and holzers method. Modal analysis.

UNIT-IV

Introduction to Condition Monitoring, Failure types, investigation and occurrences. Causes of failure, Vibration measuring instruments, vibration transducers, signal conditioning elements. Display and recording elements. Vibration meters and analyzers. Condition Monitoring through vibration analysis.Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards.

UNIT-V

Contaminant analysis, SOAP and other contaminant monitoring techniques. Special vibration measuring techniques - Change in sound method, Ultrasonic measurement method, Shock pulse measurement, Kurtosis, Acoustic emission monitoring, Cepstrum analysis, Modal analysis, critical speed analysis, Shaft –orbit & position analysis.

Suggested Reading:

1. Rao S .S Mechanical Vibrations , 5 Edition, Prentice Hall, 2011
2. V.P.Singh, Mechanical vibrations, DhanpatRai Publications, 2015
3. Collacott, R.A., *Mechanical Fault Diagnosis and Condition Monitoring,* Chapman & Hall, London, 1982.
4. John S. Mitchell, *Introduction to Machinery Analysis and Monitoring,* Penn Well Books, Penn Well Publishing Company, Tulsa, Oklahoma, 1993.
5. J S Rao, Vibration condition monitoring of machines, CRC Press, 2000
6. Nakra, B.C. Yadava, G.S. and Thuested, L., *Vibration Measurement and Analysis,* National Productivity Council, New Delhi, 1989.

Course Code	Course Title						Core/Elective
PE 5125 CD	**Computational Fluid Dynamics**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To convert the conservation equations of fluid flow in differential form into algebraic equations and apply numerical methods to obtain solutions.
- To learn the finite difference method.
- To learn finite volume method and solution methodology for fluid flow problems

Course Outcomes

At the end of this course, students will be able to

1. Understand the concepts of turbulence and fluid dynamics
2. Determine and develop the partial differential equations for various conditions
3. Design the grid for different applications
4. Determine the finite difference solutions
5. Analyze the systems using finite volume method

UNIT-I

Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Differential equations for steady and unsteady state heat conduction. Differential equations for diffusion. Introduction to turbulence, Turbulence models-mixing length model, K- turbulence Model.

UNIT-II

Classification of PDEs – Elliptic, parabolic and hyperbolic euqations. Initial and boundary value problems. Concepts of Finite difference methods – forward, backward and central difference. Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.

UNIT-III

Grid Generation- Types of grid O,H,C. Coordinate transformation, algebraic methods. Unstructured grid generation.

UNIT-IV

Finite difference solutions-Parabolic PDEs – Euler, Crank Nicholson, Implicit methods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressible flow using Stream function – Vorticity method & MAC method.

UNIT-V

Introduction to Finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.

Suggested Reading:

1. PradipNiyogi, Chakrabartty SK, Laha M.K., „Introduction to Computational Fluid Dynamics", Pearson Education, 2005.

2. Muralidhar K, Sundararajan T, „Computational Fluid flow and Heat transfer", Narosa Publishing House, 2003.
3. Chung, T J, „Computational Fluid Dynamics", Cambridge University Press, 2002.
4. John D Anderson, „Computational Fluid Dynamics", McGraw Hill, Inc., 1995.
5. Patankar, S.V, „Numerical Heat transfer and Fluid flow", Hemisphere Publishing Company, New York, 1980.

Course Code	Course Title						Core/Elective
PE 5126 CD	**Robotic Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To develop the student's knowledge in various robot structures and their workspace.
- To develop student's skills in performing spatial transformations associated with rigid body motions.
- To develop student's skills in perform kinematics analysis of robot systems.
- To provide the student with knowledge of the singularity issues associated with the operation of robotic systems.
- To provide the student with some knowledge and analysis skills associated with trajectory planning.
- To provide the student with some knowledge and skills associated with robot control

Course Outcomes

At the end of this course, students will be able to

1. Understand the subsystems like grippers, actuators etc for the robots
2. Analyze the Kinematics of the robotic system
3. Understand the concepts of inverse kinematics
4. Apply the concepts to determine the forces and control of robots
5. Understand the various sensors and controllers that can be utilized for robots

UNIT-I

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT-II

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, DenavitHartenbergnotation,representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT-III

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks.

UNIT-IV

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, Computed torque control, force control, hybrid control.

UNIT-V

Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic

applications, image acquisition and preprocessing. Segmentation and region characterization object recognition by image matching and based on features

Suggested Reading:

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
4. Harry Asada &Slottine "Robot Analysis& Control" , Wiley Publications, 2014
5. S K Saha, "introduction to Robotics ", 2nd edition, TMH, 2013

Course Code	Course Title						Core/Elective
PE 5127 CD	**Advanced Meterology**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To learn the concepts relate to measurements
- To study about the gauges and comparators
- To learn about measuring machines, thread measurement and forms of errors caused during surface measurement

Course Outcomes

At the end of this course, students will be able to

1. Understand the measurement and calibration standards
2. Analyze the utility and application of gauges and comparators
3. Understand the concepts of measuring machines
4. Determine the form errors
5. Understand the details of measurement of different parameters of screw threads

UNIT-I

End & line standards for length, Airy & Bessel points, desirable features of end standards, slip gauge manufacture, calibration of end standards by interferometry. NPL gauge interferometer, calibration of line standards by micrometer microscope – superposition, coincidence and symmetric straddling, photoelectric microscope and Moir fringe techniques, measurement of large displacements using lasers, calibration of Tomlinson gauges by interferometry. Photoelectric Autocollimator, calibration of polygons & circular scales. Types of interchangeability, dimensional chains.

UNIT-II

Fixed & Indicating Gauges: Taylor‟s principles of gauge design, limitations of ring & plug gauges, position and receiver gauges, types of indicating gauges. Comparators: Multirange Sigma comparator, Back pressure and free flow type pneumatic comparators, Differential back pressure gauge, usage of different types of jets, contact &non contact tooling. Amplification selection. Air to electric transducer, Differential transducer, Variation transducer, Pre process, In-process & Post process gauging, computation & match gauging. Usage of LVDT & Capacitive type gauge heads, Automatic inspection.

UNIT-III

Measuring Machines: Floating carriage diameter measuring m/c. Universal measuring m/c. Matrix internal diameter measuring machine. Optical dividing head. Coordinate measuring machine, Optical projector-light beam systems, Work tables, measurement techniques, fixturing& accessories. Sources of error in measurement. Design principles of measuring machines Abbe‟s rule, Kelvin coupling, flexible steel strip, advantages & limitations of hydrostatic & aerostatic bearings.

UNIT-IV

Form Errors: Evaluation of straightness & flatness, usage of beam comparator, evaluation of roundness – intrinsic & extrinsic datums. Talyrond. PGC, RGC, MZC & LSC, methods, roundness evaluation for even & odd number of lobes. Surface Finish: stylus instrument (TALYSURF). M & E Systems, numerical assessment, vertical & horizontal descriptors, profile as a random process, usage of interferograms. Plastic replica technique.

UNIT-V

Screw Threads: Measurement of thread elements for internal & external threads, progressive periodic, drunkenness and irregular pitch errors. NPL pitch measuring machine, virtual effective diameter, thread gauging. Gears: measurement of tooth thickness, involute profile, pitch, concentricity and alignment, rolling gear test.

Suggested Reading:

1. R.K.Jain, Engineering Metrology, Khanna Publishers
2. ASTME, Hand Book of Industrial Metrology, Prentice Hall of India Pvt Ltd.
3. I.C. Gupta, A Text Book of Engineering Metrology, DhanpatRai& Sons.

Course Code	Course Title						Core/Elective
PE 5128 CD	**Control of Dynamic Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To introduce the concepts of control systems and develop the ability of formulating mathematical models and designing feedback control systems.
- To provide students with the necessary tools to analyze feedback (linear) controls systems
- An ability to analyze, design, simulate, and experimentally validate linear and non linear control systems while taking into account practical limitations of operations.
- An understanding of negative and positive feedback systems and their application to circuit analysis and control system design
- An understanding of frequency compensation and its application to linear and nonlinear control system design

Course Outcomes

At the end of this course, students will be able to

1. Apply mathematical modeling for different physical systems
2. Analyze the poles and zeros
3. Determine the state space methods
4. Analyze the non linear systems
5. Understand the stability of the various systems

UNIT-I

Mathematical Modeling of physical systems, 1st, 2nd order and higher order systems, transient, steady state analysis, steady state errors, Performance Indices.

UNIT-II

Poles, zeros, zero and pole placements, Routh‟s criteria, Root locus Technique, Bode plots, Nyquist criterion, Compensation circuits

UNIT-III

State space method, state transition matrix, canonical forms, Diagonalisation, solutions of homogeneous and non homogenous equations, zero and pole placement using state space techniques, controllability and observability, state controllability matrix, state observability matrix.

UNIT-IV

Non-Linear Systems Phase plane analysis: Phase portraits, Singular points characterization. Analysis of non-linear systems using phase plane techniques, Existence of limit cycles.

UNIT-V

Stability Analysis Concept of stability, Stability in the sense of Lyapunov and absolute stability, autonomous systems, the invariance principle, linear systems and linearization, non autonomous systems, linear time varying systems and linearization.

Suggested Reading:

1. K. Ogata, “Modern Control Engineering”, Pearson India, 3rd Edition.

2. Norman Nise,"Control System Engineering", Prentice Hall India, Fourth Edition
3. Anand Kumar, "Control System Theory", Prentice Hall India.
4. M.Vidyasagar, "Nonlinear systems analysis", Second Edition, Prentice Hall, 1993
5. H.Khalil, "Nonlinear Systems", Macmillan Publishing Company, NY, 1992.
6. A.Isidori, "Nonlinear Control Systems" 3rd edition, Springer Verlag, London, 1995.
7. B.Brogliato, R. Lozano, B. Maschke, O. Egeland, "Dissipative Systems Analysis and Control",SpringerVerlag, London, 2nd edition, 2007.

Course Code	Course Title						Core/Elective
PE 5129 CD	**Advanced Materials Technology**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Provides the knowledge and practice regarding different Material & their behavior.
- Gives hands on practice regarding Elastic, Plastic & Failure behaviour.
- Gives knowledge for material selection and basic of Composite Materials.

Course Outcomes

At the end of this course, students will be able to

1. Understand the elastic and plastic behavior of the material for which it is utilized.
2. Understand the Fracture Behavior of the materials.
3. Do selection of the material for which it is going to be utilized.
4. Identify applications of all kind of Industrial Materials.
5. Judge Metallurgical Effects on Materials.

UNIT-I

Elastic and Plastic Behavior: Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solution hardening, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviors - Super plasticity - Deformation of non crystalline material.

UNIT-II

Fracture Behavior: Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of non metallic materials – Failure Analysis, sources of failure, procedure of failure analysis.

UNIT-III

Selection of Materials: Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

UNIT-IV

Modern Metallic Materials: Dual phase steels, Micro alloyed, High strength low alloy (HSLA), steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nanocrystalline materials, bio materials.

UNIT-V

Non Metallic Materials

Composite materials: Types, production techniques of each type, Production of fibers, properties mechanics of composites, manufacturing of metal matrix, Ceramic matrix composite, Carbon-Carbon composite-properties and testing of composite material, areas of application.

Plastics, rubber, foams, adhesives and coatings - Structure, properties and applications of engineering polymers.

Advanced structural ceramics: WC, TiC, TaC, AI_2O_3, SiC, Si_3N_4, CBN and diamond - properties, processing and applications.

Suggested Reading:

1. Thomas H. Courtney, " Mechanical Behavior of Materials ", McGraw-Hill, 2000.
2. Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials", 3rd Edition, Butterworth-Heinemann, 1977.
3. Flinn, R.A. and Trojan, P.K., "Engineering Materials and their Applications ", (4th Edition), Jaico Publishing, 1999.
4. George E. Dieter, "Mechanical Metallurgy ", McGraw Hill, 1988.
5. Metals Hand Book, Vol.10, "Failure Analysis and Prevention ", (10th Edition), 1994.
6. Willam D. Callister, Jr., "Material Science and Engineering: An introduction", John Wiley & Sons, Inc, 2003.
7. Willam F. Smith, "Principles of Materials Science and Engineering", 3rd edition, McGraw Hill, 2002.

Course Code	Course Title						Core/Elective
PE 5130 CD	**Failure Analysis and Design**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To explain the importance of Good design and various factors affecting it
- To explain the importance of Ergonomics and Aesthetics in good design.
- To understand the importance of various scientific methods available to solve problems arising from product initiation state to product delivery state.
- To understand the phenomenon & importance of Fracture, its determination by various methods also understand the effect of fatigue on crack propagation.

Course Outcomes

At the end of this course, students will be able to

1. Understand the design fundamentals
2. Analyze the utility and application of different design methods
3. Understand the concepts of fracture mechanics
4. Understand the service failure analysis
5. Understand the concepts related to fatigue crack propagation

UNIT-I

DESIGN FUNDAMENTALS Importance of design- The design process-Considerations of Good Design – Morphology of Design –Organization for design– Computer Aided Engineering –Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.

UNIT-II

DESIGN FUNDAMENTALS Importance of design- The design process-Considerations of Good Design – Morphology of Design –Organization for design– Computer Aided Engineering –Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.

UNIT-III

FRACTURE MECHANICS: Introduction, Modes of fracture failure Griffith Analysis, Energy release rate, Energy release rate of DCB specimen; Stress Intensity Factor: SIF‘s for edge and centre line crack, Fracture toughness, Elastic plastic analysis through J-integral method: Relevance and scope, Definition of J-integral, Path independence, stress strain relation, Strain Energy Release Rate Vs J-integral. Failure analysis and determination of stress patterns from plastic Flow observations – Dynamic loading– Fracture types in tension.

UNIT-IV

APPLICATIONS OF FRACTURE MECHANICS Introduction –Through cracks emanating from holes – Corner cracks at holes – Cracks approaching holes-Combined loading-Fatigue crack growth binder- Mixed mode loading-Fracture toughness of weld metals-Service failure analysis

UNIT-V

FATIGUE CRACK PROPOGATION— Mechanism of fatigue crack initiation, propagation and growth, Fatigue data representation, Factors influencing Fatigue strength, Fatigue life prediction, prevention of fatigue failures, corrosion fatigue. Cumulative fatigue damage

Suggested Reading:

1. Ibrahim Dieter, George E., ―Engineering Design - A Materials and Processing Approach‖, McGraw Hill, International Editions, Singapore, 2000.
2. Pahl, G, and Beitz, W.,‖ Engineering Design‖, Springer – Verlag, NY. 1984.
3. David Broek, ‖Elementary Engineering Fracture Mechanics ―, Fifthoff and Noerdhoff International Publisher, 1978.
4. Prashant Kumar, ―Elements of Fracture Mechanics‖, Wheeler Publishing, 1999
5. S T. Rolfe and J M Barsom, Fracture and Fatgue control in structure, Prentice Hall
6. KRY Simha, Fracture Mechanics for Modern Engineering Design, University Press

Course Code	Course Title						Core/Elective
MC 5121 ME	**Research Methodology and IPR**						**Mandatory Course**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

To make students to

- Motivate to choose research ascareer
- Formulate the research problem, prepare the researchdesign
- Identify various sources for literature review and data collection reportwriting
- Equip with good methods to analyse the collecteddata
- Know about IPRcopyrights

Course Outcomes

1. Define research problem, review and asses the quality of literature from varioussources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various researchdesigns
3. Collect the data by various methods: observation, interview,questionnaires
4. Analyse problem by statistical techniques: ANOVA, F-test,Chi-square
5. Understand apply for patent andcopyrights

UNIT - I

Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods Verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem

UNIT - II

Literature Survey and Report writing: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Need of Review, Guidelines for Review, Record of Research Review.

Report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanism of writing a report. **Research ProposalPreparation**: Writing a Research Proposal and Research Report, Writing Research GrantProposal.

UNIT - III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.

UNIT - IV

Data Collection and Analysis: Methods of data collection, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Importance of Parametric, non-parametric test, testing of variance of two normal populations, use of Chi-square, ANOVA, F-test, z-test

UNIT - V

Intellectual Property Rights: Meaning, Nature, Classification and protection of Intellectual Property, The main forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, Granting of patent, Rights of a patent, Licensing, Transfer of technology.

Suggested Readings:

1. C.R Kothari, Research Methodology, Methods & Technique‖; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers‖, MJP Publishers, 2011
3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation‖, Sterling Publications Pvt. Ltd., New Delhi, 2004
4. G.B. Reddy, Intellectual Property Rights and the Law 5th Ed. 2005 GogiaLaw Agency
5. AjitParulekar and SaritaD'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd, 2006

Course Code	Course Title						Core/Elective
OE 9101 CE	**Cost Management of Engineering Projects**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To apply modern software packages to conduct analysis of real worlddata.
- To understand the technical underpinning of engineering economicanalysis.
- The ability to apply the appropriate analytical techniques to a widevariety of real world problems and data sets.
- To summarize and present the analysis results in a clear and coherentmanner.

Course Outcomes

1. Students should be able to learn the cost concepts in decision making
2. Student should be able to do cost planning and Marginal Costing
3. Students should be able to create a database for operational control and decision making.

UNIT-I

Introduction and Overview of the Strategic Cost Management Process: Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT-II

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT-III

Cost Behavior and Profit Planning Marginal Costing: Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

UNIT-IV

Activity-Based Cost Management: Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT-V

Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Readings:

1. Cost Accounting – A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

Course Code	Course Title						Core/Elective
OE 9102 CS	**Business Analytics**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand the role of business analytics within an organization
- Analyse data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making
- To become familiar with processes needed to develop, report, and analyse business data
- Use decision-making tools/Operations research techniques
- Mange business process using analytical and management tools
- Analyse and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.
- Student will able to understand the basic rules of research formulation and procedure for obtaining patent rights

Course Outcomes

1. Students will demonstrate knowledge of data analytics
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modelling to support business decision-making
4. Students will demonstrate the ability to translate data into clear, actionable insights

UNIT-I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT-II

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression.Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT-III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT-IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT-V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without 8 Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Recent Trends in Embedded and collaborative business intelligence, Visual data 4 recovery, Data Storytelling and Data journalism.

Suggested Readings:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Course Code	Course Title						Core/Elective
OE 9103 EC	**Embedded System Design**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Detailed overview of important concepts of Embedded system
- Analyse PIC microcontroller, its features and programming
- Describe ARM Microcontroller architectural details and instruction set
- Understand ARM Memory management
- Learn the techniques to develop an embedded system and case studies

Course Outcomes

After completing this course, the student will be able to:

1. Understand the fundamentals of the embedded system design
2. Enumerate the instruction set of ARM Processor by studying the architecture of ARM core
3. Acquire knowledge on the serial, parallel and network communication protocols.
4. Learn the embedded system design life cycle and co-design issues.
5. List the various embedded software development tools used in the design of embedded system for various applications.

UNIT I

Introduction to Embedded Systems: Overview of Embedded System Architecture,Challenges& Trends of Embedded Systems, Hardware Architecture, Software Architecture. Application areas of Embedded Systems and Categories of Embedded Systems. Embedded System Design and Co-Design issues and Design Cycle Process

UNIT II

PIC 18: Family Overview, Architecture, Instruction Set, Addressing modes. Timers,interrupts of PIC 18, Capture/Compare and PWM modules of PIC 18

UNIT III

ARM Architecture: ARM Design Philosophy, Registers, Program Status Register,Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families. Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions.

UNIT IV

ARM Thumb Instruction Set: Register Usage, Other Branch Instructions, DataProcessing Instruction Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions. Exception and interrupt handling.

ARM Memory Management: Cache Architecture, Polices, Flushing and Caches, MMU, PageTables, Translation Access Permissions, Context Switch.

UNIT V

Embedded Software Development Tools, Host and Target Machines, Linkers/Locators forEmbedded Software, Getting Embedded Software into the Target System. Debugging Techniques.

Case Studies: Design of Embedded Systems using Microcontrollers–for applications in the area ofcommunications and automotives. (GSM/GPRS, CAN, Zigbee)

Suggested Readings:

1. Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd Edition, TMH, 2008.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM Systems Developer's Guides – Designing & Optimizing System Software, Elsevier, 2008.
3. Mazidi, MCKinlay and Danny Causey, PIC Microcontrollers and Embedded Systems, Pearson Education, 2007
4. David.E. Simon, An Embedded Software Primer, 1st Edition, Pearson Education, 1999
5. Jonathan W. Valvano, Embedded Microcomputer Systems, Real Time Interfacing, Thomas Learning, 1999.

Course Code	Course Title						Core/Elective
OE 9104 EE	**Waste to Energy**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To enable students to aware about the generation of energy from the waste.

Course Outcomes

1. Students should able to learn the Classification of waste as a fuel.
2. Students should able to learn the Manufacture of charcoal.
3. Students should able to carry out the designing of gasifiers and biomass stoves.
4. Student should able to learn the Biogas plant technology.

UNIT-I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors. Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-II

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-III

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-IV

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction

UNIT-V

Biochemical conversion: Anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Readings:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book, Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, TataMcGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Code	Course Title						Core/Elective
OE 9105 ME	**Industrial Safety**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Causes for industrial accidents and preventive steps to betaken.
- Fundamental concepts of MaintenanceEngineering.
- About wear and corrosion along with preventive steps to betaken
- The basic concepts and importance of faulttracing.
- The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

Course Outcomes

After completing this course, the student will be equipped with:

1. concepts of engineering systems safety
2. Identify the causes for industrial accidents and suggest preventivemeasures.
3. Identify the basic tools and requirements of different maintenanceprocedures.
4. Apply different techniques to reduce and prevent Wear and corrosion inIndustry.
5. Identify different types of faults present in various equipments like machine tools, IC Engines,boilers etc.
6. Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine toolsetc.

UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety colour codes. Fire prevention and firefighting, equipment and methods.

UNIT-II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT-IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air

compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Suggested Readings:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, McGraw Hill Publication
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London

Course Code	Course Title						Core/Elective
AD 9001 HS	**English for Research Paper Writing**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand that how to improve your writing skills and level ofreadability
- Understand the nuances of language and vocabulary in writing a ResearchPaper.
- Develop the content, structure and format of writing a researchpaper.
- Produce original research papers withoutplagiarism

Course Outcomes

After completing this course, the student will be able to:

1. Interpret the nuances of research paperwriting.
2. Differentiate the research paper format and citation ofsources.
3. To review the research papers and articles in a scientificmanner.
4. Avoid plagiarism and be able to develop their writing skills in presenting theresearch work.
5. Create a research paper and acquire the knowledge of how and where to publishtheir original researchpapers.

UNIT - I

Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.

UNIT - II

Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

UNIT - III

Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

UNIT - IV

Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft –Revising/Editing - The final draft and proof reading.

UNIT - V

Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – Advantages/Benefits

Presentation Skills: Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

Suggested Readings:

1. C. R Kothari, Gaurav, Garg, ―Research Methodology Methods and Techniques‖, 4/e, New Age International Publishers.
2. Day R, ―How to Write and Publish a Scientific Paper**",** Cambridge University Press, 2006
3. MLA Hand book for writers of Research Papers‖, 7/e, East West Press Pvt. Ltd, New Delhi
4. LauriRozakis, Schaum's, Quick Guide to Writing Great Research Papers‖, Tata McGraw Hills Pvt. Ltd, New Delhi.

Course Code	Course Title						Core/Elective
AD 9002 CE	**Disaster Management**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various naturaldisasters
- To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
- To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic,etc.

Course Outcomes

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction
2. and humanitarian response.
3. Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.
4. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in**.**

UNIT-I

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT-III

Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT-IV

Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-IV

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning,

People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal Book Company.
2. Sahni, Pardeep (Eds.),"Disaster Mitigation Experiences and Reflections", PHI, New Delhi.
3. Goel S. L., "Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Course Code	Course Title						Core/Elective
AD 9003 HS	**Sanskrit for Technical Knowledge**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in theworld
- To make the novice Learn the Sanskrit to develop the logic in mathematics, science &othersubjects
- To explore the huge knowledge from ancient Indianliterature

Course Outcomes

1. Develop passion towards Sanskrit language
2. Decipher the latent engineering principles from Sanskritliterature
3. Correlates the technological concepts with the ancient Sanskrithistory.
4. Develop knowledge for the technologicalprogress
5. Explore the avenue for research in engineering with aid ofSanskrit

UNIT-I

Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatmentonly)

UNIT-II

Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series).

The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).

UNIT-III

Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):

Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower-Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingalachandasutram (origination of digital logic system)

UNIT-IV

Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vedic command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.

UNIT-V

Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthiyanthram

Suggested Readings:

1. M Krishnamachariar, History of Classical Sanskrit Literature, TTD Press, 1937.
2. M.R. Kale, A Higher Sanskrit Grammar: For the Use of School and College Students, MotilalBanarsidass Publishers, 2015.
3. Kapail Kapoor, Language, Linguistics and Literature: The Indian Perspective, ISBN- 10: 8171880649, 1994.
4. Pride of India, SamskritaBharati Publisher, ISBN: 81-87276 27-4, 2007.
5. Shri RamaVerma, Vedas the source of ultimate science, Nag publishers, 2005.

Course Code	Course Title						Core/Elective
AD 9004 HS	**Value Education**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand the need and importance of Values for self-development and for Nationaldevelopment.
- Imbibe good human values andMorals
- Cultivate individual and National character.

Course Outcomes

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

1. Gain necessary Knowledge for self-development
2. Learn the importance of Human values and their application in day to day professionallife.
3. Appreciate the need and importance of interpersonal skills for successful career and sociallife
4. Emphasize the role of personal and social responsibility of an individual for all-roundgrowth.
5. Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universalbrotherhood.

UNIT-I

Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture andtradition.

UNIT-II

Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT-III

Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religioustolerance.

UNIT-IV

Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role ofWomen.

UNIT-V

Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasicgunas.

Suggested Readings:

1. Chakroborty,S.K., Values & Ethics fororganizations Theory and practice‖,Oxford University Press, New Delhi,1998.
2. Jaya DayalGoyandaka, Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur,2017.

Course Code	Course Title						Core/Elective
AD 9011 HS	**Constitution of India and Fundamental Rights**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective and to address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

Course Outcomes

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

UNIT-I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT-IV

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: ZillaPanchayat, Elected officials and their roles, CEO ZillaPanchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT-V

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Readings:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Code	Course Title						Core/Elective
AD 9012 HS	**Pedagogy Studies**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To present the basic concepts of design and policies of pedagogystudies.
- To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessmentpractices.
- To familiarize various theories of learning and their connection to teachingpractice.
- To create awareness about the practices followed by DFID, other agencies and otherresearchers.
- To provide understanding of critical evidence gaps that guides the professionaldevelopment

Course Outcomes

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informalclassrooms.
2. Examine the effectiveness of pedagogicalpractices.
3. Understand the concept, characteristics and types of educational research and perspectives ofresearch.
4. Describe the role of classroom practices, curriculum and barriers tolearning.
5. Understand Research gaps and learn the futuredirections.

UNIT-I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT-II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT-III

Evidence on the Effectiveness of Pedagogical Practices: Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT-IV

Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT-V

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

Suggested Readings:

1. Ackers J, Hardman F, Classroom Interaction in Kenyan Primary Schools, Compare‖, 31 (2): 245 – 261, 2001.
2. Agarwal M, Curricular Reform in Schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3. Akyeampong K, Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER), Country Report 1. London: DFID, 2003.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J, Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count? International Journal Educational Development, 33 (3): 272- 282, 2013.
5. Alexander R J, Culture and Pedagogy: International Comparisons in Primary Education, Oxford and Boston: Blackwell, 2001.
6. Chavan M, Read India: A mass scale, rapid, learning to read campaign, 2003.

Course Code	Course Title						Core/Elective
AD 9013 HS	**Stress Management by Yoga**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

The Course will introduce the students to

- Creating awareness about different types of stress and the role of yoga in the management ofstress.
- Promotion of positive health and overall wellbeing (Physical, mental, emotional, social andspiritual).
- Prevention of stress related health problems by yogapractice.

Course Outcomes

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

1. Understand yoga and itsbenefits.
2. Enhance Physical strength andflexibility.
3. Learn to relax andfocus.
4. Relieve physical and mental tension throughasanas.
5. Improve work performance andefficiency.

UNIT - I

Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT - II

Meaning and Definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT - III

Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress

UNIT - IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT - V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation Techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

Suggested Readings:

1. "Yogic Asanas for Group Training - Part-I",Janardhan Swami YogabhyasiMandal, Nagpur.
2. Swami Vivekananda, "Rajayoga or Conquering the Internal Nature", AdvaitaAshrama (Publication Department), Kolkata.
3. Nagendra H.R and Nagaratna R, "Yoga Perspective in Stress Management", Swami Vivekananda Yoga Prakashan, Bangalore.

Course Code	Course Title						Core/Elective
AD 9014 HS	**Personality Development Through Life Enlightenment Skills**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes

1. Develop their personality and achieve their highest goal oflife.
2. Lead the nation and mankind to peace andprosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work andduties.
5. Develop a versatilepersonality.

UNIT - I

Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT - II

Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75& 78 (do's) - Approach to day to day works and duties.

UNIT - III

Introduction to Bhagavadgeetha for Personality Development - ShrimadBhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT - IV

Statements of Basic Knowledge - ShrimadBhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from ShrimadBhagawatGeeta.

UNIT - V

Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Readings:

1. Srimad Bhagavad Gita, Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam(Niti-sringar-vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

Online Resources: NTPEL: http://nptel.ac.in/downloads/109104115/

Course Code	Course Title						Core/Elective
PC 5151 CD	**Advanced CAD Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Outcomes

At the end of this course, students will be able to

1. Execute surface modeling
2. Execute sheet metal modeling
3. Execute solid modeling
4. Understand the concepts of production drawing and execute it using CAD software

List of Exercises:

1. Understand the various commands related to surface modeling
2. Create 2/3 components of using the surface modeling commands
3. Understand the various commands related to sheet metal modeling
4. Create components using sheet metal modelling and understand the significance of sheet metal components
5. Introduction to solid modeling various commands
6. Creation of various parts of 2 or 3 components
7. Assembling of part models using constraints, part modifications, adding another assembly features – display
8. Creation of engineering drawing details such as dimensioning, sectional views, adding esthetics

Course Code	Course Title						Core/Elective
PC5152 CD	**CAM and Automation Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Outcomes

At the end of this course, students will be able to

1. Carry out CNC programming on Lathe operations
2. Carry out CNC programming on Milling operations
3. Execute the PLC programming for various applications

List of Exercises:

Understanding of CNC Machines and CNC Programming and Creation of

1. Facing, turning, step turning, taper turning, contouring etc. on CNC lathe machine.
2. Pocketing and contouring on CNC milling machine.
3. Simulation and development of NC code using any CAM software.
4. Programming for integration of various CNC machines, robots and material handling systems.
5. Implementation of Logic gates(AND, OR, XOR, NAND) using PLC
6. Implementation of Stepper motor control using PLC.
7. PLC program to Latch and Unlatch output with time delay
8. PLC program to drive motors simultaneously with interlocking

Course Code	Course Title						Core/Elective
PC 5153 CD	**Computational Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Outcomes

At the end of this course, students will be able to

1. Determine the stiffness and loading matrices for various applications
2. Carry out structural analysis of various components
3. Determine the bending and deflection in components

List of Exercises:

1. To determine the stiffness matrix and loading matrices in Beams
2. To determine the B matrix, loading matrices in plane
3. Introduction to Finite Element Analysis Software.
4. Static analysis of a corner bracket.
5. Statically indeterminate reaction force analysis. (Truss/bar element-basic)
6. Determination of Beam stresses and Deflection. (Cantilever and Simply supported beams)
7. Bending of a circular plate using axisymmetric shell element
8. Stress analysis using plane stress and plane strain

Course Code	Course Title						Core/Elective
PC 5154 CD	**Advanced CAE Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Outcomes

At the end of this course, students will be able to

1. Carry out the model analysis
2. Execute the buckling analysis
3. Determine the contact and coupled field analysis
4. Execute CFD analysis
5. Demonstration the utility of advanced software's for Casting and additive manufacturing

List of Exercises:

1. Modal analysis of beams, plates and shells for natural frequencies and mode shapes
2. Steady state heat transfer Analysis
3. Buckling analysis of plates, shells and beams to estimate BF and modes
4. CFD analysis of aerofoil design
5. Coupled field analysis problem
6. Contact Analysis problem
7. Analysis of Solidification of casting
8. Additive manufacturing

Course Code	Course Title						Core/Elective
PC 1155 CD	**Mini Project with Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**4**	**100**	**-**	**2**

Course Outcomes

1. Formulate a specific problem and givesolution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results anddiscussions
4. Conclude the resultsobtained
5. Write the documentation in standardformat

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work forassessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something moreoriginal.
- Mini projects shall have inter-disciplinary/ industryrelevance.
- The students can select a mathematical modeling based/Experimental investigations or Numerical modeling
- All the investigations should be clearly stated and documented with thereasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions andreference

Departmental committee: Supervisor and a minimum of two faculty members

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

Course Code	Course Title						Core/Elective
PC 1156 CD	**Major Project Phase – I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**20**	**100**	**-**	**10**

Course Outcomes

At the end of this course, students will be able to

1. Exposed to self-learning varioustopics.
2. Learn to survey the literature such asbooks, journals and contact resource persons for the selected topic ofresearch.
3. Learn to write technical reports.
4. Develop oral and written communication skills topresent.
5. Defend their work in front of technically qualifiedaudience

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, O.U and Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, O.U. and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

Course Code	Course Title						Core/Elective
PC 1157 CD	**Major Project Phase – II (Dissertation)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**32**	**-**	**200**	**16**

Course Outcomes

At the end of this course, students will be able to

1. Use different experimental techniques and will be able to use different software/ computational /analyticaltools.
2. Design and develop an experimental set up/ equipment/testrig.
3. Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analysingthem.
4. Either work in a research environment or in an industrialenvironment.
5. Conversant with technical report writing and will be able to present and convince their topic of study to the engineeringcommunity.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester -III.
- The student has to submit the report in prescribed format and also present aseminar.
- The dissertation should be presented in standard format as provided by thedepartment.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results anddiscussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head, O.U.and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS& Head, O.U. and together	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application tosociety and Scope for futurestudy
	20	Viva-Voce

FACULTY OF ENGINEERING

Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2019-2020)
(AICTE Model Curriculum for the Academic Year 2020-2021{III & IV Sem})

and

Syllabus

M.E. I to IV Semester

of

Two Year Post Graduate Degree Programme

in

Mechanical Engineering
Specialization in Heating, Ventilation and Air-Conditioning (HVAC)

(With effect from the academic year 2019– 2020)
(As approved in the faculty meeting held on 25-06-2019)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2019

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Mechanical Engineering) I – Semester
Specialization in Heating, Ventilation and Air-Conditioning (HVAC)

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Core	Program Core – I	3	1	-	4	30	70	3	4
2	Core	Program Core – II	3	-	-	3	30	70	3	3
3	Elective	Professional Elective – I	3	-	-	3	30	70	3	3
4	Elective	Professional Elective – II	3	-	-	3	30	70	3	3
5	MC or OE	MC/Open Elective*	3	-	-	3	30	70	3	3
6	Audit	Audit Course – I	2	-	-	2	30	70	3	0
Practical/ Laboratory Courses										
7	Lab-I	Laboratory – I	-	-	2	2	25	50	3	1
8	PC 5254 HV	Seminar	-	-	2	2	25	50	3	1
		Total	**17**	**01**	**04**	**22**	**230**	**520**		**18**

PC: Program Core **PE:** Professional Elective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a Clock Hour.
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
3. * If the Mandatory Course is offered in I-Semester, the Open Elective course should be offered in II-semester. If Open Elective course is offered in I-Semester, then the Mandatory Course should be offered in II- semester.
4. ** Open Elective Subject is not offered to the students of Mechanical Engineering Department.

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Mechanical Engineering) II – Semester
Specialization in Heating, Ventilation and Air-Conditioning (HVAC)

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Core	Program Core – III	3	1	-	4	30	70	3	4
2	Core	Program Core – IV	3	1	-	3	30	70	3	4
3	Elective	Professional Elective – III	3	-	-	3	30	70	3	3
4	MC or OE	Open Elective/MC	3	-	-	3	30	70	3	3
5	Audit	Audit Course – II	2	-	-	2	30	70	3	0
Practical/ Laboratory Courses										
6	Lab-II	Laboratory – II	-	-	2	2	25	50	3	1
7	Lab-III	Laboratory – III	-	-	2	2	25	50	3	1
8	PC 5255 HV	Mini Project with Seminar	-	-	4	4	25	50	3	2
		Total	**14**	**02**	**08**	**24**	**300**	**450**		**18**

PC: Program Core **PE:** Professional Elective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a Clock Hour.
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
3. ** Open Elective Subject is not offered to the students of Mechanical Engineering Department.

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Mechanical Engineering) III – Semester
Specialization in Heating, Ventilation and Air-Conditioning (HVAC)

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Elective	Professional Elective – IV	3	-	-	3	30	70	3	3
2	Elective	Professional Elective – V	3	-	-	3	30	70	3	3
3	PC 5256 HV	Major Project Phase – I	-	-	20	20	100	-	3	10
		Total	**06**	**-**	**20**	**26**	**160**	**140**		**16**

M.E. (Mechanical Engineering) IV – Semester
Specialization in Heating, Ventilation and Air-Conditioning (HVAC)

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PC 5257 HV	Major Project Phase – II (Dissertation)	-	-	32	32	-	200	3	16
		Total	**-**	**-**	**32**	**32**	**-**	**200**		**16**

PC: Program Core **PE:** Professional Elective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a Clock Hour
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
3. ** Open Elective Subject is not offered to the students of Mechanical Engineering Department.
4. The students who are willing to register for MOOCs in the M. Tech (HVAC) III – semester instead of Professional Electives – IV & V, should register for those of the courses, approved by the CBoS, OU and respective college MOOCs Coordinator. Those students are strictly not permitted to appear for either CIE or SEE of Professional Electives – IV & V if they abstain from attending the semester classwork. Further, for students willing to appear for both MOOCS and Professional Electives, they should fulfil the minimum attendance criteria.

List of subjects of Professional Core

S. No.	Course Code	Course Title
1	PC 5201 HV	Refrigeration
2	PC 5202 HV	Air-Conditioning
3	PC 5203 HV	Ventilation and Indoor Air Quality
4	PC 5204 HV	HVAC Systems Design

List of subjects of Professional Electives I to V

S. No.	Course Code	Course Title
1	PE 5216 HV	Energy Conversion and Management
2	PE 5217 HV	Cryogenic Engineering
3	PE 5218 HV	Climatology for Built Environment
4	PE 5219 HV	Refrigeration and Air-Conditioning Equipment
5	PE 5220 HV	Green Building Concepts
6	PE 5221 HV	Advanced Heat Transfer
7	PE 5222 HV	Design of Air Distribution System
8	PE 5223 HV	Automotive Air-Conditioning
9	PE 5224 HV	Air-Conditioning Instrumentation and Control Systems
10	PE 5225 HV	Maintenance of HVAC Equipment
11	PE 5226 HV	Unconventional Refrigeration and AC Systems
12	PE 5227 HV	Equipment Design for Thermal Systems
13	PE 5228 HV	Cold Storage Technology and Systems
14	PE 5229 HV	Alternative Energy Sources
15	PE 5230 HV	Renewable Energy Sources

List of Mandatory Courses

S. No.	Course Code	Course Title
1	MC 5161 ME	Research Methodology & IPR

List of Open Electives

S. No.	Course Code	Course Title
1	OE9101CE	Cost Management of Engineering Projects
2	OE9102CS	Business Analytics
3	OE9103EC	Embedded System Design
4	OE9104EE	Waste to Energy
5	OE9105ME**	Industrial Safety

Note: ** Open Elective Subject is not offered to the students of Mechanical Engineering Department.

List of subjects of Audit Course-I

S. No.	Course Code	Course Title
1	AD 9001 HS	English for Research Paper Writing
2	AD 9002 CE	Disaster Management
3	AD 9003 HS	Sanskrit for Technical Knowledge
4	AD 9004 HS	Value Education

List of subjects of Audit Course-II

S. No.	Course Code	Course Title
1	AD 9011 HS	Constitution of India and Fundamental Rights
2	AD 9012 HS	Pedagogy Studies
3	AD 9013 HS	Stress Management by Yoga
4	AD 9014 HS	Personality Development through life Enlightenment Skills

List of Laboratory Courses

S. No.	Lab No.	Course Code	Course Title
1	I	PC 5251 HV	Refrigeration Lab
2	II	PC 5252 HV	Air-Conditioning Lab
3	III	PC 5253 HV	HVAC Systems Design Lab

Course Code	Course Title						Core/Elective
PC 5201 HV	**Refrigeration**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- To apply the principles of Thermodynamics to analyse different types of refrigeration systems and to understand the functionality of the major components.
- To analyse the cycle performance of vapour compression system under varying temperature and pressure variables
- To analyse the cycle performance of vapour absorption system with respect to varying enthalpy and concentration
- To compare and analyse different air craft refrigeration system and unconventional refrigeration system
- To analyse steam jet refrigeration system and industrial refrigeration processes
- To understand the classification and application of refrigerants and the need for alternative refrigerants

Course Outcomes

After completing this course, the student will be able to:

1. Understand the fundamental principles and applications of refrigeration systems
2. Differentiate between different types of refrigeration systems with respect to application
3. Differentiate between conventional and unconventional refrigeration systems.
4. Evaluate performance parameters of refrigeration systems
5. Classify the refrigerants and understand its applications
6. Choose the most appropriate system for a particular application

UNIT- I

Vapour Compression System: Analysis of vapour compression refrigeration cycle Reverse Carnot Cycle for vapour. Effect of suction temperature and condensing temperature on cycle performance. Practical refrigeration cycle, Sub cooled liquid and super-heated vapour refrigeration cycles, their effect on performance. Multi-pressure system. Removal of flash gas, inter cooling. Compound compression Multi vapour- Cascade system- dry ice system

UNIT -II

Vapour Absorption System: Simple Vapour Absorption System-Actual vapour absorption cycle representation on enthalpy concentration h-c diagram, Water lithium bromide absorption system. Electrolux refrigerator- Aqua Ammonia Refrigeration System – Enthalpy Concentration Diagram

UNIT-III

Aircraft Refrigeration: Thermodynamic Cycle – Different systems – Analysis – Comparison Un Conventional Refrigeration: Thermoelectric refrigeration system, Vortex refrigeration system, Pulse refrigeration.

UNIT-IV

Steam jet water vapour system: Analysis and Exercises Industrial Refrigeration: Chemical and process industries, Diary plants, Petroleum Refineries

UNIT-V

Refrigerants: Primary and secondary refrigerants. Designation of refrigerants, Desirable properties of refrigerants such as solubility in water and lubricating oil. Material compatibility, Toxicity, Flammability, Thermodynamic properties of refrigerants, Inorganic, Halocarbon refrigerants. Secondary refrigerants. Refrigerants mixtures, Need for Alternate refrigerants – Retrofitting aspects

Suggested Reading:

1. Principles of Refrigeration / Roy. J. Dossat
2. Refrigeration and Air Conditioning / F. Stoecker & Jerold. W. Jones./ MGH Intrl 1982
3. Refrigeration and Air Conditioning / C.P Arora./ TMG).
4. Refrigeration and Air Conditioning /Manohar Prasad.

Course Code	Course Title						Core/Elective
PC 5202 HV	**Air-Conditioning**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand Vapour compression and vapour absorption system operation
- To analyse the refrigeration cycles and methods for improving Performance
- To familiarize the components of refrigeration systems
- To design air conditioning systems using cooling load calculations
- To know Selection of outside and inside design conditions of an air conditioning system

Course Outcomes

After completing this course, the student will be able to:

1. Explain the principles and applications of refrigeration and air conditioning systems
2. Differentiate the various types of refrigeration and air conditioning systems.
3. Design and Analyse various refrigeration and air conditioning systems.
4. Select methods for performance improvement of refrigeration and air conditioning systems
5. Comparing the seasonal air conditioning refrigeration systems
6. Identifying the selection of outside and inside design conditions of air conditioning systems

UNIT - I

Psychrometry: Properties of moist air. Important Psychrometry properties, Dry bulb temperature, Humidity ratio, degree of saturation, Dew point temperature and Enthalpy, Psychometric chart and ASHRAE chart.

UNIT - II

Applied Psychrometry: Psychrometric processes in air conditioning equipment, Mixing, Bypass factor, Heating and dehumidifying coils, Air washers. Cooling by dry and wet coils, Use of hygroscopic solution in air washers, Adiabatic dehumidifiers. Humidifiers, Water injection. Steam injection.

UNIT- III

Comfort Air Conditioning and Cooling Load Calculations: Sensible and Latent Heat Loads, sensible heat factor. Use of Effective and grand sensible heat factor, Relationship between ESHF, ADP and BF. Representation of All Fresh Air, Recirculated air, Bypassed Air and High Latent Heat Load systems on Psychrometric Chart

UNIT- IV

Air Conditioning Systems: Commercial, Residential and Industrial Air-Conditioning; Summer, Winter and Year round Air-Conditioning system, Hot and dry outdoor conditions. Hot and humid outdoor conditions.

UNIT - V

Selection of outside and inside design conditions: Thermodynamics of human body. Body regulation process against heat and cold. Comfort & Comfort chart, Effective temperature, Factors governing optimum effective temperature, Design considerations. Air conditioning control systems: Basic elements of the control system, Temperature, Humidity & Pressure controls, Refrigeration, Room thermostat.

Suggested Reading:

1. Refrigeration & Air Conditioning / C.P. Arora / TMH

2. Refrigeration & Air Conditioning / Arora & Domkundwar / Dhanpat Rai & Co.
3. Refrigeration & Air Conditioning / R C Arora / PHI / 2012
4. Hand Book of Air Conditioning System Design / Carrier
5. Refrigeration & Air Conditioning / S.C. Jain / Chand and Co.
6. ASHRAE Hand Book / Volume 1& 2.

Course Code	Course Title						Core/Elective
PC 5203 HV	**Ventilation and Indoor Air Quality**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

The objectives of this course is to impart knowledge of

- Learning the fundamentals of good indoor air quality, effects of relative humidity, control of microbial growth in building ventilation.
- The concepts of devices used in supply ventilation system
- Describe criteria and types of exhaust ventilation system
- Design considerations for kitchen ventilation system
- Basic design consideration for commercial and residential ventilation system

Course Outcomes

After completing this course, the student will be able to:

1. Illustrate the fundamentals of good indoor air quality need for building ventilation
2. Understand the devices used in supply ventilation system
3. Apply the design considerations for kitchen ventilation system
4. Analyse the exhaust ventilation system
5. Evaluate the international mechanical codes for kitchen ventilation system
6. Design Ventilation system for commercial and residential buildings

UNIT - I

Introduction: Fundamentals of good indoor air quality Need for building ventilation, Effects of R.H. in building ventilation, Control of microbial growth, Psychometric performance of contact volume system. Types of ventilation system. Supply system, Exhaust system.

UNIT - II

Devices Used in Supply Systems: Air Inlet system. Filters heating & cooling equipment, Fans, Duct, Grills, Diffusers, for distribution of air in the work place.

UNIT - III

Exhaust Systems: General exhaust systems. Local exhaust system, Removal of pollutants and contaminated air. Air cleaning devices, Fans.

UNIT - IV

Ventilation in Kitchen: Cooking, Exhaust flow, IMC (International Mechanical Code) Calculation of appliances area, contaminated air, free foot area. Total air flow volume with example. Types of hood, Design of hood. Design factors, integrated air curtains, Combination hood.

UNIT-V

Ventilation of Commercial Buildings: Design of commercial, Residential ventilation system.

Suggested Reading:

1. Ventilation Systems: Design and Performance/ Hazim B. Awbi. / Routledge / 2007.
2. Portable Ventilation Systems Hand Book / Neil McManus / CRC Press / 2000.
3. Design of Industrial Ventilation Systems / John L Alden / Industrial Press / 5th Edition.

4. Industrial Ventilation Applications / ISHRAE Hand Book / 2009.
5. Engineering bulletin / TRANE Company.
6. HVAC Hand book / ISHRAE.
7. Industrial Ventilation Applications / ASHRAE Hand Book / 2009.

Course Code	Course Title						Core/Elective
PC 5204 HV	**HVAC Systems Design**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- To calculate direct, diffuse and reflected radiation as well as to understand clearly about various incident radiation related parameters
- To calculate angle of incidence for horizontal, vertical and tilted surfaces such as walls
- To compare and contrast the conventional cooling and heating load calculations
- To understand the concept and application of various air heating systems as well as to make aware the various trouble shooting measures for common arising problems
- To classify and contrast the various water heating systems based on piping arrangement and water circulation

Course Outcomes

After completing this course, the student will be able to:

1. List the factors that impact the heating & cooling loads in buildings
2. Understand the internal and external cooling loads on a building by separating sensible and latent parts
3. Calculate the heating & cooling loads using CLTD/CLF method
4. Analyse the various HVAC systems available and selecting the most appropriate one
5. Choose appropriate air heating system for a particular location and application
6. Design an HVAC system for a residential or commercial building

UNIT - I

Heat Transfer Through Building Structures: Building Survey, Periodic heat transfer through walls and roofs. Empirical methods to calculate heat transfer through walls and roofs; Heat gain through glass, calculation of solar heat gain through ordinary glass tables, shading devices, effect of shading devices. Equivalent temperature difference method, Thermal resistance of various building materials, Infiltration, stack effect, wind effect.

UNIT - II

Heat Load Calculations: Winter heating load calculation, heat losses through structure, heat losses due to infiltration, Effects of solar radiation and internal heat sources on heating loads. Methods for estimating energy requirements for heating.

UNIT - III

HVAC System Design: Principles of HVAC system design and analysis; component and system selection criteria including room air distribution, fans and air circulation, humidifying and dehumidifying processes, piping and ducting design. Air quality standards. Control systems and techniques; operational economics. The engineering principles and key factors influencing the thermal environments and quantification of these factors, functional requirements of utilities, and the design of systems to local codes.

UNIT - IV

Air conditioning systems: Ventilation Systems; Space Heating Systems; Automatic control; Commissioning, operation and maintenance; Introduction to HVAC & R analysis. Thermal equipment performance; Direct contact heat and mass transfer; Component modelling and simulation; Performance

analysis and optimization of environmental plant systems. Part-load and year-round operation, system performance and operational problems; Ventilation systems: outdoor air control, ventilation effectiveness, ADPI, fan-duct network; filtration systems

UNIT - V

Systems: Primary and secondary water loops, constant and variable flow; System control: air side control, water side control; Energy requirement: cooling load profile, fan and pump power, system operation for energy effectiveness and heat recovery, chiller optimization. Thermal environment; Air quality; Energy conservation measures; Energy codes; Noise and vibration control

Suggested Reading:

1. HVAC Fundamentals Volume-l / James E. Brumbou / Audel / 4th Edition
2. Fundamentals of HVAC Systems / Robert Mcdowall / Academic Press / 2007
3. Home Heating & Air Conditioning systems / James Kittle / MGH
4. HVAC Fundamentals / Samuel C. Sugarman / Fairmont Press / 2005.
5. Principles of Refrigeration – Dossat, Pearson
6. R&AC Hand Book by ISHRAE

Course Code	Course Title						Core/Elective
PE 5216 HV	**Energy Conversion and Management**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand and appreciate the energy crisis and environmental concerns associated with the energy management
- To be able to do Energy Audit
- To acquire the skills of energy efficiency analysis and energy conversion & management in the routinely used thermal and electrical energy systems
- To understand the energy conservation and management technologies and strategies

Course Outcomes

After completing this course, the student will be able to:

1. Understand concepts of energy crisis and environmental concerns and on the importance of energy efficiency, conservation and management
2. Comprehend the techniques and having the skills for the energy conservation and management in the thermal energy systems
3. Apply the techniques and having the skills for the energy conservation and management in the electrical energy systems
4. Analyze energy monitoring and auditing, and the energy management systems
5. Evaluate to the most used energy planning and management software.
6. Formulate strategy to use alternate sources of energy

UNIT - I

Introduction: Principles of energy management. Managerial organization, Functional areas for i) manufacturing industry, ii) Process industry, iii) Commerce, iv) Government, Role of Energy manager in each of these organizations. Initiating, Organizing and managing energy management programs

UNIT - II

Energy Audit: Definition and concepts. Types of energy audits, Basic energy concepts, Resources for plant energy studies. Data gathering, Analytical techniques.

Energy Conservation: Technologies for energy conservation, Design for conservation of energy materials, Energy flow networks. Critical assessment of energy usage. Formulation of objectives and constrains, Synthesis of alternative options and technical analysis of options. Process integration.

UNIT - III

Economic Analysis: Scope, Characterization of an investment project. Types of depreciation, Time value of money. Budget considerations, Risk analysis.

UNIT- IV

Methods of Evaluation of Projects: Payback, Annualized costs, Investor's rate of return, Present worth, Internal rate of return, Pros and cons of the common method of analysis, Replacement analysis.

UNIT - V

Alternative Energy Sources: Solar Energy, Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy, Availability, Wind Devices, Wind Characteristics, performance of turbines and systems.

Suggested Reading:

1. Energy Management Hand Book / W. C. Turner (Ed)
2. Energy Management Principles / CB Smith/ Pergamon Press
3. Energy Management / W. R. Murthy and G. Mc. Kay / BS Publication
4. Management / H. Koontz and Cyrill Donnel / McGraw Hill
5. Financial Management / S. C. Kuchhal / Chaitanya Publishing House

Course Code	Course Title						Core/Elective
PE 5217 HV	**Cryogenic Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learning the mechanical properties, methods to protect the cryogenic fluids
- To describe liquefaction system for Neon, Hydrogen and Helium
- To explain the cryogenic gas separation and purification system
- To explain the cryogenic refrigeration systems
- To embark on a research career in Cryogenic Engineering

Course Outcomes

1. List the applications of cryogenic systems
2. Understand the principles of cryogenics engineering
3. Analyse the performance of cryogenics gas liquefaction system
4. Analyse performance of cryogenics gas separation and purification system
5. Evaluate material properties at cryogenic temperature
6. Design the cryogenic storage system & cryo coolers

UNIT - I

Introduction to Cryogenic Systems: Mechanical Properties at low temperatures. Properties of Cryogenic Fluids. Gas Liquefaction: Minimum work for liquefaction. Methods to protect low temperature. Liquefaction systems for gages other than Neon. Hydrogen and Helium.

UNIT - II

Liquefaction Systems for Neon, Hydrogen and Helium: Components of Liquefaction systems. Heat exchangers. Compressors and expanders. Expansion valve, Losses in real machines.

UNIT- III

Gas Separation and Purification Systems: Properties of mixtures, Principles of mixtures, Principles of gas separation, Air separation systems.

UNIT-IV

Cryogenic Refrigeration Systems: Working Medium, Solids, Liquids, Gases, Cryogenic fluid storage & transfer, Cryogenic storage systems, Insulation, Fluid transfer mechanisms, Cryostat, Cryo Coolers

UNIT-V

Applications: Space technology, In-Flight air separation and collection of LOX, Gas industry, Biology, Medicine, Electronics.

Suggested Reading:

1. Cryogenic Systems/ R.F. Barren/ Oxford University Press
2. Cryogenic Engineering- Thomas Flynn- CRC Press-2nd Edition
3. Cryogenic Research and Applications: Marshal Sitting/ Von Nostrand/ Inc. New Jersey
4. Cryogenic Heat Transfer/ R.F.Baron
5. Cryogenic Engineering Edit / B.A. Hands/ Academic Press, 1986
6. Cryogenic Engineering/ R.B. Scottm Vin Nostrand/ Inc. New Jersey, 1959

7. Experimental Techniques in Low Temperature Physics- O.K. White, Oxford Press, 1968
8. Cryogenic Process Engineering/ K. D. Timmerhaus & TM Flynn/ Plenum Press, 1998
9. Hand Book of Cryogenic Engineering – J.G. Weisend –II, Taylor and Francis, 1998

Course Code	Course Title						Core/Elective
PE 5218 HV	**Climatology foe Built Environment**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the basic science of sustainable development.
- To familiarize and understand the different climatic zones in the country
- Comprehend and calculate the heat transfer in buildings
- To appreciate the importance of solar shades and natural ventilation
- To utilize the potential of energy conservation though passive cooling.

Course Outcomes

After completing this course, the student will be able to:

1. Define the built environment and building climatology
2. Understand the external and climatic effects on the indoor environment
3. Demonstrate understanding of building materials and heat transfer through buildings
4. Analyse the impact of shading devices and natural ventilation on interior heat loads
5. Evaluate the effectiveness of energy conservation through passive cooling strategies
6. Design thermally comfortable and energy efficient buildings

UNIT I

Introduction to Building Climatology: Climate and built form interaction. Global Climatic factors, elements of climate, macro and micro climate; challenge of rapid, extreme environmental change

UNIT II

Tropical Climates: Definition, classification of tropical climates, characteristics of different climatic zones, Design considerations for warm-humid, hot-dry, composite and upland climates.

UNIT III

Thermal Comfort: Thermal comfort factors, Physiological aspects, Body heat balance, Heat flow through Buildings: Basic principles of heat transfer through buildings, performance of different materials, Periodic heat flow.

UNIT IV

Sun and the Design process: Solar geometry, Solar charts, Sun angles and shadow angles, orientation for sun, shading devices, building form and heat gain, basic principles of day lighting, sunlight and glare.

Natural Ventilation: Air movement around and through buildings, Orientation for wind, stack effect, Induced ventilation.

UNIT V

Passive Cooling:

Passive methods of Cooling, roof pond, desiccant cooling, evaporative Cooling, and earth sheltered buildings etc. Site Planning (including landscaping) and building planning and design considering climate factors. Detailed appraisal/analysis of climatological performance of an existing residence and or a workplace; followed by redesigning or the same to improve climatological performance.

Suggested Reading:

1. Koenigsberger, O.H. and Others. Manual of Tropical Housing and Building. Orient Longman, Chennai, 2003.
2. Konya, Allan. Design for Hot Climates.
3. Kukreja, C.P. Tropical Architecture. Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 1978.
4. Markus, T.A. and Morris. E.N. Buildings, Climate and Energy. Pitman Pub. Ltd., London, 1980.
5. Olgyay and Olgyay. Solar Control and Shading Devices.

Course Code	Course Title						Core/Elective
PE 5219 HV	**Refrigeration and Air-Conditioning Equipment**						**Elective**
	Contact Hours per Week						
Prerequisite	L	T	D	P	CIE	SEE	Credits
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of and problem solving skills in

- The types of compressors, comparison and their control circuits
- The types of condensers and the transfer heat from medium.
- The types of evaporators, comparison and working
- The installation and testing &commissioning of the refrigeration.

Course Outcomes

After completing this course, the student will be able to:

1. Define the types and compare compressor control circuits
2. Understand the types of condensers and explain their working principles
3. Apply the fouling correction factor in evaporators
4. Analyse the counter flow cooling tower
5. Weigh the types of expansion devices & flow controls
6. Design the vapour compression refrigeration system

UNIT - I

Compressors: Types, constructional details of reciprocating compressors, volumetric efficiency factors affecting volumetric efficiency, effects of evaporator and condenser pressures, centrifugal compressor, constructional details, applications: Comparison with reciprocating compressors, screw compressors, working principle, single screw and double screw compressor, lubricating oils, rotary compressor, single vane and multi vane compressor surging, Electric motors and control circuits.

UNIT - II

Condensers: Types - water cooled & air cooled condensers-evaporative type, thermal design of compressor-temperature distribution and heat flow in a condenser, pressure drop, fouling factor, LMTD correction factor. (No problems) Cooling Towers: Classification, performance of cooling towers, analysis of counter flow cooling towers, enthalpy-temperature diagram of air and water. Cooling ponds: types, cross flow cooling towers, procedure for calibration of outlet conditions.

UNIT - III

Evaporators: Types - flooded & dry evaporators, natural & forced convection type, shell &tube, shell & coil, plate type-secondary evaporators, temperature distribution and heat flow in evaporators-pressure drop, fouling correction factor, (no problems)

UNIT - IV

Expansion Devices - Capillary tube, thermostatic expansion valve, float valve, automatic expansion valve, solenoid control valve, pipe design, general-water piping, refrigerant piping & steam piping water treatment corrosion control, scale formation control-Refrigerant flow controls.

UNIT - V

Installation of Vapour Compression Refrigeration System: evaluation & dehydration, testing for leakages, charging, adding oil defrosting, methods-material, automatic, periodic defrosting-solid & liquid

adsorbents; water defrosting, defrosting by reversing the cycle, automatic hot gas defrosting-thermo balance defrosting, electric control defrosting (no problems)

Suggested Reading:

1. Principles of Refrigeration/Roy J. Dossat
2. Refrigeration & Air-Conditioning / C. P. Arora/
3. Refrigeration & Air-Conditioning / Stoecker/ TMGH 1982
4. Refrigeration & Air-Conditioning / Domkundwar/Danapath Rai
5. ASHRAE guide & data book application

Course Code	Course Title						Core/Elective
PE 5220 HV	**Green Building Concepts**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Identify and compare existing energy codes, green building codes and green rating systems.
- Identify and compare cost and performance of building materials.
- Identify and use construction materials and methods that more easily allow for salvage and re-use of building materials.
- Perform demolition in ways that allow for salvage of re-usable building materials.
- Understand the techniques and benefits of building performance testing, monitoring and metering.
- Identify and make use of techniques for sustainable remodeling of existing structures

Course Outcomes

After completing this course, the student will be able to:

1. State the key regulatory tools, including building codes, design guidelines, as well as relevant legislation governing the consumption of resources and emission of environmental pollutants by buildings
2. Understand the multidisciplinary process of conceptualizing an eco-friendly building
3. Choose and size building components, as well as energy and environmental systems suitable for different categories of buildings, and for different climate zones
4. Utilize a variety of tools and methodologies suitable for evaluating the resource consumption and overall environmental performance (environmental footprint) of buildings in different stages of their life cycles
5. Evaluate the economic performance of buildings (operating & maintenance costs, real estate value)
6. Design an environmentally friendly green building

UNIT-I

Overview of the significance of energy use and energy processes in building: Indoor activities and environmental control, Internal and external factors on energy use and the attributes of the factors, Characteristics of energy use and its management, Macro aspect of energy use in dwellings and its implications.

UNIT-II

Indoor environmental requirement and management: Thermal comfort, Ventilation and air quality, Air-conditioning requirement, Visual perception, Illumination requirement, Auditory requirement.

UNIT-III

Climate, solar radiation and their influences: Sun-earth relationship and the energy balance on the earth's surface, Climate, wind, solar radiation, and temperature, Sun shading and solar radiation on surfaces, Energy impact on the shape and orientation of buildings.

UNIT-IV

End-use, energy utilization and requirements: Lighting and day lighting, End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance

of building envelope, Steady and non-steady heat transfer through the glazed window and the wall, Standards for thermal performance of building envelope, Evaluation of the overall thermal transfer.

UNIT-V

Energy management options: Energy audit and energy targeting, Technological options for energy management.

Suggested Reading:

1. J. Krieder and A. Rabl, Heating and Cooling of Buildings - Design for Efficiency, McGraw Hill, 1994.
2. S.M. Guinnes and Reynolds, Mechanical and Electrical Equipment for Buildings, Wiley, 1989.
3. Shaw, Energy Design for Architects, AEE Energy Books, 1991.
4. ASHRAE, Handbook of Fundamentals, Atlanta, 1997.
5. Donald W. Abrams, Low Energy Cooling – A Guide to the Practical Application of Passive
6. Cooling and Cooling Energy Conservation Measures, Van Nostrand Reinhold Co., New York, 1986.

Course Code	Course Title						Core/Elective
PE 5221 HV	**Advanced Heat Transfer**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- To provide the technical understanding the concepts of heat transfer in real engineering problems
- To understand the fundamentals of heat transfer mechanisms in fluids and solids
- To know the applications of various heat transfer equipment in process industries
- To understand the heat transfer concepts, apply to other domain of thermal engineering in general

Course Outcomes

After completing this course, the student will be able to:

1. Ability to understand and solve conduction, convection and radiation problems
2. Apply the basic principles of classical heat transfer in real engineering application
3. Analyse the analytical and numerical solutions for heat transfer problem
4. Evaluate heat transfer coefficients for natural convection and forced convection
5. Develop solutions for transient heat conduction in simple geometries
6. Compare radiation heat transfer between black body surfaces and grey boy surfaces

UNIT - I

Brief Introduction to Different Modes of Heat Transfer: Conduction: General heat Conduction equation-initial and boundary conditions.

ID Steady State Heat Conduction – Composite Systems – Systems with Heat Generation – Fins

2D Steady State Heat Conduction – Analytical solution for simple boundary conditions – Product Solution

UNIT - II

Transient heat conduction: Lumped system analysis-1D Transient Heat Conduction, Heisler charts, semi-infinite solid, use of shape factors in conduction.

Finite Difference Methods for Conduction: ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods.

UNIT - III

Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis.

External Flows: Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows.

UNIT - IV

Internal flows: Fully developed flow: integral analysis for laminar heat transfer coefficient, types of Flow, constant wall temperature and constant heat flux boundary conditions, hydrodynamic &thermal entry lengths; use of empirical correlations.

Free Convection: Boussinesque approximation, different geometries, combined free and forced convection.

UNIT - V

Boiling and condensation: Boiling curve, correlations for different regimes, Condensation: Film and Dropwise condensation, Nusselts theory of film condensation on a vertical plate, assumptions & correlations of film condensation for different geometries.

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces.

Suggested Reading:

1. Heat Transfer - A basic approach- Necati Ozisik –TMH
2. Fundamentals of Heat & Mass transfer- Incropera, Dewitt, Bergman, Lavime - wiley Publication
3. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press
4. Heat Transfer-S. P. Sukhatme - Univeristies Press
5. Fundamentals of Engineering Heat Transfer-R.C. Sachdeva-New Age Science.
6. Heat Transfer/ P. K. Nag /TMH
7. Engg. Heat & Mass Transfer/ Sarit K. Das/Dhanpat Rai
8. Introduction to Heat Transfer/SK Som/PHI
9. Principals of Heat Transfer/Frank Kreith/Cengage Learning

Course Code	Course Title						Core/Elective
PE 5222 HV	**Design of Air Distribution Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learning the fundamental principles of Air conditioning systems and different methods for load calculation during summer and winter. Using ASHRAE Standards.
- Study of various outlets and its mechanism of flow through out lets. Duct design, duct construction using SMACNA.
- Study of different insulation for heated building cooled building and cooled storage.
- Understand the basic of fan and blowers and its selection on fan characteristic curve. Piping network for supply and return and pipe sizing using ASHRAE Standards.
- Study of the various air conditioning systems for Automobiles, Train, Ships, Aircraft and for some special applications.

Course Outcomes

After completing this course, the student will be able to:

1. Illustrate the fundamental principles and applications of air conditioning system and difference between summer and winter load calculation.
2. Understand diffuser types, obtain sound power level of diffuser, face area and noise level, Air duct design and duct procedure.
3. Calculate the rate of heat transfer, Presenting the properties, applications and environmental issues of different duct insulation.
4. Analyse the Fan selection, Static pressure calculation, water supply pipe sizing, fitting loses per ASHRAE Standard. Used for various applications
5. Operate and analyse the air conditioning systems.
6. Solve Air conditioning design problems using P-h, T-S and Psychometric charts

UNIT- I

Air Conditioning Systems: All-water, All-air, air-water system. Unitary System, window air conditioner, split and central air conditioning system, cooling load calculations, occupancy load, lighting load, appliance load, product load, difference between summer & winter load calculations.

UNIT- II

Air Distribution: Room Air distribution - types of supply air outlets, mechanism of flow through outlets, selection and location of outlets, general considerations. Distribution patterns of outlets, ducts, Definition and types - materials for ducts and its specification, friction loss in ducts, grills, diffusers, registers, rectangular equivalent of circular duct. Air duct designs, duct construction, duct design procedure.

UNIT- III

Thermal Insulation for A/C System: Method of heat transfer, desired properties of ideal insulating materials, types of insulating materials. Heat transfer through insulation, economic thickness of insulation. Insulation of heated buildings, Insulation for cooling building and cold storage, pipe insulation.

UNIT- IV

Air Conditioning Apparatus: Fans and blowers, types of fans, fan characteristic, centrifugal fans, axial fans, fan arrangements, filters, sources of noise and control, static pressure calculation for selection of motor

and fan. Water supply pipe sizing calculations, piping network for supply and return water line, pipe fittings, lining and insulation, piping system as per ASHRAE standards

UNIT- V

Applications: Air conditioning systems for automobiles (cars, buses, etc.), Air conditioning systems for trains, ships, & aircraft; Special applications: Computers, hospitals, cold storages, printing, textiles and leather industries.

Suggested Reading:

1. Refrigeration & Air-Conditioning by Domkundwar
2. Refrigeration &Air-Conditioning by V.K. Jain
3. Refrigeration & Air-Conditioning by C.P. Arora
4. ASHRAE Hand Book
5. Hand Book of Air Conditioning System design by Carrier

Course Code	Course Title						Core/Elective
PE 5223 HV	**Automotive Air-Conditioning**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand location of automotive air-conditioning components.
- To acquire knowledge of controlled air conditioner heating system.
- To study the different control systems.
- To provide the knowledge of servicing of AC equipment.

Course Outcomes

After completing the course, the students will able to

1. Define the fundamental principles and parts of refrigeration and air-conditioning system
2. Understand the controlled air conditioner & heating system in automotives
3. Demonstrate the knowledge of refrigeration system diagnosis, refrigerant leakage etc.
4. Analyse refrigerant flow, controlling the temperature of refrigerant as per requirement.
5. Judge the servicing of air conditioner by repairing and / or replacing of parts.
6. Design the automotive air conditioning system.

UNIT - I

Air Conditioning Fundamentals: Basic air conditioning system - location of air conditioning components in a car, schematic layout of a refrigeration system, compressor components, condenser and high pressure service ports, thermostatic expansion valve, expansion valve calibration, controlling evaporator temperature, evaporator pressure regulator, evaporator temperature regulator.

UNIT - II

Air Conditioning – Heating Systems: Automotive heaters, manually controlled air conditioner, heater system, automatically controlled air conditioner and heater systems, automatic temperature control, air conditioning protection, engine protection.

UNIT - III

Refrigerant: Containers handling refrigerants, tapping into the refrigerant container, refrigeration system diagnosis, diagnostic procedure, ambient conditions affecting system pressures.

UNIT - IV

Air Routing and Temperature Control: Objectives, evaporator airflow through the recalculating unit, automatic temperature control, duct system, controlling flow, vacuum reserve, testing the air control and handling systems.

UNIT - V

Air Conditioning Service: Air conditioner maintenance and service, servicing heater system removing and replacing components, trouble shooting of air controlling system, compressor service.

Suggested Reading:

1. William H. Crouse and Donald I. Anglin - “Automotive Air conditioning” - McGraw Hill Inc. - 1990.

2. Mitchell information Services, Inc - "Mitchell Automatic Heating and Air Conditioning Systems" - Prentice Hall Ind. - 1989.
3. Paul Weiser – "Automotive Air Conditioning" – Reston Publishing Co., Inc., - 1990.
4. MacDonald, K.I., - "Automotive Air Conditioning" – Theodore Audel series – 1978
5. Goings. L.F. – "Automotive Air Conditioning" – American Technical services – 1974.
6. Boyce H. Dwiggins – "Automotive Air Conditioning" – Delmar – 2002.
7. "Principles of Refrigeration"; Roy J Dossat: Pearson Education Inc.
8. "Refrigeration and Air Conditioning"; Arora and Damkondwar: Dhanpat Rai and Company.
9. "Refrigeration and Air Conditioning", C. P. Arora: Tata McGraw Hills Pub.

Course Code	Course Title						Core/Elective
PE 5224 HV	**Air-Conditioning Instrumentation and Control Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand the basic principles and performance characteristics of measurement.
- Understand the principles of various measuring instruments.
- Apply the working of various measuring instruments.
- Visualize the advantages and limitations of various measuring instruments.
- Comprehend the applications of various measuring instruments.
- Apply the elements of Air Conditioning controls.

Course Outcomes

1. Identify various elements and their purpose in typical instruments
2. Understand the various errors that would occur in instruments.
3. Apply static and dynamic characteristics of instrument and should be able to determine loading response time.
4. Analyse errors so as to determine correction factors for each an instrument.
5. Evaluate an appropriate calibration methodology for instruments & control systems
6. Investigate the vibration, acceleration, pressure, flow, temperature and strain measurement.

UNIT-I

Vibration and Acceleration Measurement: Vibration and acceleration measuring instruments - linear acceleration using strain gauges, capacitive, mechanical and electronic tachometers.

UNIT-II

Pressure Measurement: Resistive, magnetic, capacitive pressure transducers - Thermal conductive gauges- Mc-leod gauge, ionization gauge - pressure, measurement using strain gauges.

UNIT-III

Flow Measurements: Different types of flow transducers - Magnetic flow meters -interferometer for visualization - Rotameter other conventional types of obstruction meters.

Level Indicators: Magnetic type float gauge - Oscillator type detectors-liquid and solid level measurement by variation of capacitance.

UNIT-IV

Cryogenic Instrumentation: Low temperature measurements, measurement of micro-temperatures.

Measurement of Strain: Use of resistance strain gauge in measuring different mechanical input systems.

UNIT-V

Air-Conditioning Controls: Introduction - Types, direct & reverse acting thermostats, with receiver controller - liquid valves, fail safe design, throttling range - dampers, outdoor air control – freeze protection - building up a control system, humidi stats and humidifiers- valve characteristics and selection.

Suggested Reading:

1. Instrumentation for engineering measurement /R.H. Cerrni & L.E. Foster/ wily 1982
2. Instrumentation in Scientific research/K.S, Lion/ Megravv Hill

3. Automatic process control/ D.P. Eckman /Wiley
4. Refrigeration and Air-Conditioning/W.F. Stooecker, J.W. Jone/ McGraw Hill 1982

Course Code	Course Title						Core/Elective
PE 5225 HV	**Maintenance of HVAC Equipment**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Analyse HVAC equipment and application.
- To describe Erection methodology
- To explain the Testing of Equipment and circuitry and trouble shoot of HVAC Equipment.
- Discuss the different types of preventive maintenance procedures in HVAC.
- Illustrate different maintenance schedules followed by various industries

Course Outcomes

1. Learn about the various HVAC equipment
2. Evaluate and understand Erection methodology
3. Explain ISI standards for Testing of Equipment condition monitoring
4. Discuss the principles of corrective and preventive measures
5. Analyse the problem solving techniques of preventive maintenance in HVAC
6. Investigate the maintenance problems like, leak detection, vacuumising , charging , trial run, etc.

UNIT - I

Refrigeration Equipment & Application: Elementary knowledge of refrigeration & air conditioning equipments e.g. compressors, condensers, evaporators & expansion devices, Air washers, Cooling towers & humidifying efficiency, Food preservation, cold storage, Refrigerate Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of air through ducts and fans, Basic difference between comfort and industrial air conditioning.

UNIT - II

Erection of R & AC Systems: Erection methodology, foundation, padding, network analysis, critical path, interconnections; safety precautions, air handling equipments, locations in the systems, corrosion, noise, vibration monitoring and control.

UNIT III

Testing of Equipments: Testings/ISI standards, testing of compressors, condensers, evaporators, and cooling towers. Testing of control systems, circuitry and trouble shoot, condition monitoring.

UNIT IV

Preventive Maintenance: TPM Principles, Corrective and preventive measures, Reliability analysis, Signature analysis, Different types of preventive maintenance procedures, Practical hints, Failure Mode and Effect Analysis, Problem Solving Techniques.

UNIT V

Maintenance Aspects: Maintenance procedures, leak detection, vacuumising, charging, trial run, prevention, lubrication, different methods. Studies on different maintenance schedules followed by various industries.

Suggested Reading:

1. Robert C. Rosciler, HVAC Maintenance, and operations Hand Book, McGraw. Hill, 1997.

2. Althouse A.D. and Turnquist C. H., Modern Refrigeration and Air conditioning, Good HeartWilcoz Co Inc., 2004.
3. ISHRAE Hand book on Refrigeration & Air conditioning, ISHRAE Bangalore, 1998.
4. Nelson C. W., Commercial and Industrial Refrigeration, McGraw-Hill, 1982.
5. Reed G. H., Refrigeration, A Practical Manual, Applied Science Publishers Ltd., London, 1982.
6. Russel E. Smithy, Electricity for Refrigeration, Heating and Air-conditioning, Duxbury Press, Massachusetts, 1980.

Course Code	Course Title						Core/Elective
PE 5226 HV	**Unconventional Refrigeration and Air-Conditioning Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Illustrate the fundamentals of unconventional refrigeration & air-conditioning
- Learning of Complete vapour compression refrigeration systems
- Description, performance, analysis of Advanced vapours compression systems.
- Fundamentals of Principles and application of steam jet refrigeration system.
- Discuss the importance Properties of mixtures of refrigerants
- The concepts of Solar thermo-mechanical refrigeration system.

Course Outcomes

1. Understand the fundamentals of unconventional refrigeration & air-conditioning.
2. Explain complete vapour compression refrigeration systems
3. Applications of Advanced vapour compression systems.
4. Analyse the importance of mixtures refrigerant selection
5. Evaluate of principles and application of steam jet refrigeration system
6. Design the solar thermo-mechanical refrigeration system

UNIT-I

Introduction to refrigeration systems: methods of refrigeration, units of refrigeration, COP. Introduction to nonconventional refrigeration technologies, Thermoelectric refrigeration, magnetic refrigeration, pulse tube refrigeration, acoustic refrigeration, steam jet refrigeration, vortex tube refrigeration. Review of vapour compression refrigeration system, vapour absorption system and adsorption systems.

UNIT-II

Thermoelectric refrigeration: principle, thermoelectric properties, Seabeck effect, Peltier effect and Thompson effect. System description, performance, analysis, Applications. Advanced vapour compression systems, compound compression, multistage evaporation. Solar based refrigeration technologies, absorption and adsorption.

UNIT-III

Introduction to Magnetic refrigeration: magneto-caloric effect, magnetic materials, magnetic refrigeration near room temperature cooling, advantages over traditional refrigeration system, clean refrigeration in future, pulse tube refrigerator, principle, analysis.

UNIT-IV

Principles and application of steam jet refrigeration system: performance analysis, vortex tube refrigeration system, system description, Applications. Modern refrigerants, Need for alternative refrigerants, eco-friendly refrigerants, properties of mixtures of refrigerants, modifications required for retrofitting, safety precautions and compatibility of refrigerants with the materials.

UNIT-V

Solar thermo-mechanical refrigeration system: Carnot refrigeration cycle, solar electric compression air conditioning, simple Rankine cycle air conditioning system. Absorption refrigeration, Thermodynamic

analysis, Energy and mass balance of Lithium bromide water absorption system, Aqua-ammonia absorption system, Calculations of COP and second law efficiency. Solar desiccant dehumidification.

Suggested Reading:

1. Arora C. P Refrigeration and Air Conditioning-Tata Mc Graw Hill, 2004
2. Arora: Refrigeration and Air-conditioning, PHI, Eastern Economy Edition, 2012
3. Gosney W. B Principles of Refrigeration, Cambridge University Press, 1983
4. Stanley W Angrist Direct Energy conversions, Allyn & Bacon, 1982
5. HJ Goldsmid, Thermoelectric Refrigeration, Springer, 1st Ed. 1995

Course Code	Course Title						Core/Elective
PE 5227 HV	**Equipment Design for Thermal Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Design and analyse the heat exchangers parallel flow, counter flow, multipass, and cross flow heat exchanger
- Design and analyse the Shell and tube heat exchanger
- Enable to carry out the performance of heat exchanger with the extended surfaces
- Design and analyse the cooling towers.

Course Outcomes

1. Understand the physics and the mathematical treatment of typical heat exchangers.
2. Apply LMTD and effectiveness methods in the design of heat exchangers and analyse the importance of LMTD approach over AMTD approach
3. Analyse the performance of double-pipe counter flow (hair-pin) heat exchangers
4. Design and analyse the shell and tube heat exchanger
5. Understand the fundamental, physical and mathematical aspects of boiling and condensation
6. Classify cooling towers and explain their technical features

UNIT -I

Classification of Heat Exchangers: Introduction, Recuperation & regeneration, Tabular heat exchangers, Double pipe, shell & tube heat exchanger, Plate heat Exchangers, Gasketed plate heat exchanger. Spiral plate heat exchanger, Lamella heat exchanger, Extended surface heat exchanger, Plate fin and Tabular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow. Multipass, cross flow heat exchanger design calculations

UNIT-II

Double Pipe Heat Exchanger: Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature, The calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements.

Shell & Tube Heat Exchangers: Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis of performance of 1-2 heat exchanger and design of shell & tube heat exchangers, Flow arrangements for increased heat recovery, the calculation of 2-4 exchangers.

UNIT-III

Condensation of Single Vapours: Calculation of horizontal condenser, Vertical condenser, DeSuper heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser-Sub cooler, Vertical reflux type condenser. Condensation of steam.

UNIT-IV

Vaporizers, Evaporators and Reboilers: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler. Extended Surfaces: Longitudinal fins.

Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve. Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube exchanger.

UNIT-V

Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.

Suggested Reading:

1. Process Heat Transfer/D.Q.Kern/ TMH
2. Heat Exchanger Design/ A.P.Fraas and M N. Ozisicj/ John Wiley & sons, New York.
3. Cooling Towers / J.D. Gurney

Course Code	Course Title						Core/Elective
PE 5228 HV	**Cold Storage Technology and Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- The student is able to understand the different methods of chilling the fruits and vegetables.
- The student is able to know about different methods and technologies for preservation of meat, fishery product & Processing of Meat Products.
- To impart the knowledge of milk processing, fruit juice concentrations
- To impart the knowledge of refrigerated warehouse
- The students are also learning how to refrigerate the food products during transportation

Course Outcomes

After completing this course, the student will

1. List the different methods of chilling food items
2. Understand and apply the methods of processing of Meat & fishery products
3. Apply and implement the methods of milk processing & fruit juice concentrations
4. Recognize & comply safe working practices, environment regulation and housekeeping
5. Evaluate the design & construction of refrigerated warehouse
6. Design the refrigeration system in transporting the processed food items

UNIT-I

Theories and Method of Chilling: Freezing and free de-humidification, Preparation for freezing, Freezing methods. Commercial freezing methods, Sharp, quick and air blast freezing, Freezing drying, Methods of pre-cooling fruits and vegetables, Hydro cooling, Forced air cooling and Vacuum cooling.

UNIT-II

Processing of Meat Products: Refrigeration systems for carcass chilling and holding, Chilled brine spray, Sprayed coil, Dry coil systems. Chilling and freezing variety meats, overnight chilling, quick chilling. Effect of freezing temperature on quality of meat products. Fishery Products: Icing of fish. Saltwater icing. Freezing methods, Slow freezing Blast freezing, Plate Freezing and Immersion freezing offish.

UNIT-III

Dairy Products: Milk processing, Handling, Diary plant procedure. Standardizing, Pasteurization, Homogenizing, and Container filling. Fruit Juice Concentrations: Processing and quality control selection, Grading and handling of fresh fruit, Washing, Juice extraction, Heat Treatment, Flavour fortification, Packing storage and distribution, Convection methods, freezing and mechanical separation. Low temperature vacuum evaporation, Direct refrigerant contact method. Indirect refrigerant contact methods, High temperature short time evaporations.

UNIT-IV

Refrigerated Warehouse: Factors affecting warehouse design, Building location, Design reduction. Shipping and receiving plant forms. Utility space, Controlled atmospheric storage rooms. Jacketed storages. Automated warehouse insulation, Cold storage doors.

UNIT-V

Refrigerated Trucks, Trailers & Containers: Temperature control methods, Body Design & construction, Auxiliary equipment, Types of refrigeration systems. Railway refrigeration cars.

Suggested Reading:

1. Refrigeration and Air-Conditioning / C. P. Arora/ Dhanpat Rai & Co.
2. Food Processing Technology: Principles and Practice / Peter Fellows / Woodhead Publishing / 3rd Edition / 2009
3. Guide and Data Book / ASHRAE.
4. Hand Book of Air-Conditioning system design/Carrier.
5. Basic Refrigeration & Air Conditioning – P.N. Ananathanarayanan – McGraw Hill
6. Principles of Refrigeration/ Dossat-Pearson

Course Code	Course Title						Core/Elective
PE 5229 HV	**Alternative Refrigerants**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of the course are to impart knowledge of the:

- Learning the Development of Vapour Compression Refrigeration Cycle from Reverse Carnot Cycle
- Discuss refrigerant selection criteria based on thermodynamic, thermophysical, environmental and economic properties
- Learning, Charging procedure and Safety rules for the preparation of refrigerant mixtures
- Assessment of Natural Refrigerants
- Learning the different procedure for servicing RAC systems

Course Outcomes

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

1. Understand deviations from ideal vapour compression cycle
2. Classify cascade refrigeration systems
3. Analyse the classification of Refrigerants
4. Describe the numbering system used for designating refrigerants
5. Evaluate the advantages and limitations of refrigerant mixtures.
6. Assess the application of natural refrigerants.

UNIT-I

Refrigeration Cycles – analysis: Development of Vapour Compression Refrigeration Cycle from Reverse Carnot Cycle- conditions for high COP-deviations from ideal vapour compression cycle, Multi-pressure Systems, Cascade Systems-Analysis.

UNIT-II

Refrigerants: Classification of Refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues. Thermodynamic properties of refrigerants. Synthetic and natural refrigerants. Comparison between different refrigerants vis a vis applications. Special issues and practical implications. Montreal Protocol and the Kyoto Protocol

UNIT-III

Refrigerant Mixtures: Introduction, The Need for replacement refrigerants, Binary mixtures- composition, temperature composition, and enthalpy-concentration diagram, refrigerant mixtures, evaluation of thermodynamic properties, zeotropic and azeotropic mixtures, temperature glide. Charging procedure and Safety rules for the preparation of refrigerant mixtures. Advantages and limitations of refrigerant mixtures.

UNIT-IV

Assessment of Natural Refrigerants: Opportunities for the application of natural refrigerants, Use of hydrocarbons as working fluids in heat pumps and refrigeration equipment, Conversion of various HCFC-22 systems to hydrocarbon, Experimental assessment of HC-290 as a substitute to HCFC-22 in a window air conditioner

UNIT-V

Tools & Servicing Practices Tools: Different Types of Refrigeration Tools, Evacuation and Charging Unit, Recovery and Recycling Unit, Vacuum Pumps. Servicing Practices: Contaminants, Moisture on condensables, Servicing RAC systems, Evacuation, Purging, Leak detection,

Suggested Reading:

1. Natural Refrigerants Sustainable Ozone- and Climate-Friendly Alternatives to HCFCs, Proklima International, 2008
2. Refrigeration & Air Conditioning Technology, By William C. Whitman, William M. Johnson, John A.
3. Refrigeration and Air Conditioning by C P Arora, McGraw-Hill edition
4. Alternatives to HCFCs in the Refrigeration and Air Conditioning Sector - Practical Guidelines and Case Studies for Equipment Conversion, Retrofit and Replacement, UNEP
5. R & AC -Manohar Prasad

Course Code	Course Title						Core/Elective
PE 5230 HV	**Renewable Energy Sources**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of the course are to impart knowledge of:

- Understand the various forms of conventional energy resources.
- Learn the present energy scenario and the need for energy conservation
- Explain the concept of various forms of renewable energy
- Outline division aspects and utilization of renewable energy sources for both domestics and industrial application
- Analyse the environmental aspects of renewable energy resources.

Course Outcomes

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

1. Describe the environmental aspects of non-conventional energy resources in comparison with various conventional energy systems, their prospects and limitations.
2. Know the need of renewable energy resources, historical and latest developments.
3. Understand the prospects of solar energy, geothermal energy, wind energy, bio energy and ocean energy
4. Demonstrate the need to move to environmentally friendly renewable sources of energy
5. Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations.
6. Design and recommend an alternate source of energy for various applications

UNIT - I

Introduction to renewable energy resources, Energy Scenario, Survey of energy resources. Classification and need for conventional energy resources.

Solar Energy: The Sun-sun-Earth relationship, Basic matter to waste heat energy circuit, Solar Radiation, Attention, Radiation measuring instruments.

Solar Energy Applications: Solar water heating. Space heating, Active and passive heating. Energy storage. Selective surface. Solar stills and ponds, solar refrigeration, Photovoltaic generation.

UNIT - II

Geothermal Energy: Structure of earth, Geothermal Regions, Hot springs. Hot Rocks, Hot Aquifers. Analytical methods to estimate thermal potential. Harnessing techniques, Electricity generating systems.

UNIT - III

Direct Energy Conversion: Nuclear Fusion: Fusion, Fusion reaction, P-P cycle, Carbon cycle, Deuterium cycle, Condition for controlled fusion, Fuel cells and photovoltaic. Thermionic & thermoelectric generation, MHD generator.

Hydrogen Gas as Fuel: Production methods, Fuel condition, Properties, I.C. Engines applications, Utilization strategy, Performances.

UNIT- IV

Bio-energy: Biomass energy sources. Plant productivity, Biomass wastes, aerovic and Anaerobic bioconversion processed, Raw metrical and properties of bio-gas, Bio-gas plant technology and status, the energetics and economics of biomass systems, Biomass gasification

UNIT-V

Wind Energy: Wind, Beaufort number, Characteristics, Wind energy conversion systems, Types, Betz model. Interference factor. Power coefficient, Torque coefficient and Thrust coefficient, Lift machines and Drag machines. Matching, Electricity generation.

Energy from Oceans: Tidal energy. Tides. Diurnal and semi-diurnal nature, Power from tides, Wave Energy, Waves, Theoretical energy available. Calculation of period and phase velocity of waves, Wave power systems, Submerged devices. Ocean thermal Energy, Principles, Heat exchangers, Pumping requirements, Practical considerations.

Suggested Reading:

1. Non-conventional Energy Resources – Khan – McGraw Hill
2. Energy Resources Utilization and Technologies – Y Anjaneyulu and Francis Tuluri, BS Publications
3. Solar Energy – Sukhatme & Nayak – McGraw Hill
4. Alternative Energy Sources & Systems – Steeby – Cengage Learning
5. Renewable Energy Source – Tasneem & S.A. Abbasi - PHI
6. Non-conventional Energy Resourses - Sawhney-PHI

Course Code	Course Title						Core/Elective
MC 5161 ME	**Research Methodology and IPR**						**Mandatory Course**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

To make students to

- Motivate to choose research as career
- Formulate the research problem, prepare the research design
- Identify various sources for literature review and data collection report writing
- Equip with good methods to analyse the collected data
- Know about IPR copyrights

Course Outcomes

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

1. Define research problem, review and asses the quality of literature from various sources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various research designs
3. Collect the data by various methods: observation, interview, questionnaires
4. Analyse problem by statistical techniques: ANOVA, F-test, Chi-square
5. Understand apply for patent and copyrights

UNIT - I

Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods Verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem

UNIT - II

Literature Survey and Report writing: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Need of Review, Guidelines for Review, Record of Research Review.

Report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanism of writing a report. **Research Proposal Preparation**: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

UNIT - III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.

UNIT - IV

Data Collection and Analysis: Methods of data collection, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Importance of Parametric, non-parametric test, testing of variance of two normal populations, use of Chi-square, ANOVA, F-test, z-test

UNIT - V

Intellectual Property Rights: Meaning, Nature, Classification and protection of Intellectual Property, The main forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, Granting of patent, Rights of a patent, Licensing, Transfer of technology.

Suggested Readings:

1. C.R Kothari, Research Methodology, Methods & Techniquel; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineersl, MJP Publishers, 2011
3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computationl, Sterling Publications Pvt. Ltd., New Delhi, 2004
4. G.B. Reddy, Intellectual Property Rights and the Law 5th Ed. 2005 Gogia Law Agency
5. Ajit Parulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd, 2006

Course Code	Course Title						Core/Elective
OE 9101 CE	**Cost Management of Engineering Projects**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To apply modern software packages to conduct analysis of real world data.
- To understand the technical underpinning of engineering economic analysis.
- The ability to apply the appropriate analytical techniques to a wide variety of real world problems and data sets.
- To summarize and present the analysis results in a clear and coherent manner.

Course Outcomes

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

1. Students should be able to learn the cost concepts in decision making
2. Student should be able to do cost planning and Marginal Costing
3. Students should be able to create a database for operational control and decision making.

UNIT-I

Introduction and Overview of the Strategic Cost Management Process: Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT-II

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT-III

Cost Behavior and Profit Planning Marginal Costing: Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

UNIT-IV

Activity-Based Cost Management: Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT-V

Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Readings:

1. Cost Accounting – A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

Course Code	Course Title						Core/Elective
OE 9102 CS	**Business Analytics**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand the role of business analytics within an organization
- Analyse data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making
- To become familiar with processes needed to develop, report, and analyse business data
- Use decision-making tools/Operations research techniques
- Mange business process using analytical and management tools
- Analyse and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.
- Student will able to understand the basic rules of research formulation and procedure for obtaining patent rights

Course Outcomes

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

1. Students will demonstrate knowledge of data analytics
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modelling to support business decision-making
4. Students will demonstrate the ability to translate data into clear, actionable insights

UNIT-I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT-II

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT-III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT-IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT-V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without 8 Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Recent Trends in Embedded and collaborative business intelligence, Visual data 4 recovery, Data Storytelling and Data journalism.

Suggested Readings:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Course Code	Course Title						Core/Elective
OE 9103 EC	**Embedded System Design**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Detailed overview of important concepts of Embedded system
- Analyse PIC microcontroller, its features and programming
- Describe ARM Microcontroller architectural details and instruction set
- Understand ARM Memory management
- Learn the techniques to develop an embedded system and case studies

Course Outcomes

After completing this course, the student will be able to:

1. Understand the fundamentals of the embedded system design
2. Enumerate the instruction set of ARM Processor by studying the architecture of ARM core
3. Acquire knowledge on the serial, parallel and network communication protocols.
4. Learn the embedded system design life cycle and co-design issues.
5. List the various embedded software development tools used in the design of embedded system for various applications.

UNIT I

Introduction to Embedded Systems: Overview of Embedded System Architecture, Challenges & Trends of Embedded Systems, Hardware Architecture, Software Architecture. Application areas of Embedded Systems and Categories of Embedded Systems. Embedded System Design and Co-Design issues and Design Cycle Process

UNIT II

PIC 18: Family Overview, Architecture, Instruction Set, Addressing modes. Timers, interrupts of PIC 18, Capture/Compare and PWM modules of PIC 18

UNIT III

ARM Architecture: ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families. Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions.

UNIT IV

ARM Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instruction Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions. Exception and interrupt handling.

ARM Memory Management: Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation Access Permissions, Context Switch.

UNIT V

Embedded Software Development Tools, Host and Target Machines, Linkers/Locators for Embedded Software, Getting Embedded Software into the Target System. Debugging Techniques.

Case Studies: Design of Embedded Systems using Microcontrollers – for applications in the area of communications and automotives. (GSM/GPRS, CAN, Zigbee)

Suggested Readings:

1. Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd Edition, TMH, 2008.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM Systems Developer's Guides – Designing & Optimizing System Software, Elsevier, 2008.
3. Mazidi, MCKinlay and Danny Causey, PIC Microcontrollers and Embedded Systems, Pearson Education, 2007
4. David.E. Simon, An Embedded Software Primer, 1st Edition, Pearson Education, 1999
5. Jonathan W. Valvano, Embedded Microcomputer Systems, Real Time Interfacing, Thomas Learning, 1999.

Course Code	Course Title						Core/Elective
OE 9104 EE	**Waste to Energy**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To enable students to aware about the generation of energy from the waste.

Course Outcomes

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

1. Students should able to learn the Classification of waste as a fuel.
2. Students should able to learn the Manufacture of charcoal.
3. Students should able to carry out the designing of gasifiers and biomass stoves.
4. Student should able to learn the Biogas plant technology.

UNIT-I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors. Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-II

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-III

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-IV

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction

UNIT-V

Biochemical conversion: Anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Readings:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book, Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Code	Course Title						Core/Elective
OE 9105 ME	**Industrial Safety**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Causes for industrial accidents and preventive steps to be taken.
- Fundamental concepts of Maintenance Engineering.
- About wear and corrosion along with preventive steps to be taken
- The basic concepts and importance of fault tracing.
- The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

Course Outcomes

After completing this course, the student will be equipped with:

1. concepts of engineering systems safety
2. Identify the causes for industrial accidents and suggest preventive measures.
3. Identify the basic tools and requirements of different maintenance procedures.
4. Apply different techniques to reduce and prevent Wear and corrosion in Industry.
5. Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
6. Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc.

UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety colour codes. Fire prevention and firefighting, equipment and methods.

UNIT-II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT-IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air

compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Suggested Readings:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, McGraw Hill Publication
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London

Course Code	Course Title						Core/Elective
AD 9001 HS	**English for Research Paper Writing**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand that how to improve your writing skills and level of readability
- Understand the nuances of language and vocabulary in writing a Research Paper.
- Develop the content, structure and format of writing a research paper.
- Produce original research papers without plagiarism

Course Outcomes

After completing this course, the student will be able to:

1. Interpret the nuances of research paper writing.
2. Differentiate the research paper format and citation of sources.
3. To review the research papers and articles in a scientific manner.
4. Avoid plagiarism and be able to develop their writing skills in presenting theresearch work.
5. Create a research paper and acquire the knowledge of how and where to publish their original research papers.

UNIT - I

Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.

UNIT - II

Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

UNIT - III

Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

UNIT - IV

Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft –Revising/Editing - The final draft and proof reading.

UNIT - V

Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – Advantages/Benefits

Presentation Skills: Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

Suggested Readings:

1. C. R Kothari, Gaurav, Garg, ―Research Methodology Methods and Techniques‖, 4/e, New Age International Publishers.
2. Day R, ―How to Write and Publish a Scientific Paper**",** Cambridge University Press, 2006
3. MLA Hand book for writers of Research Papers‖, 7/e, East West Press Pvt. Ltd, New Delhi
4. Lauri Rozakis, Schaum's, Quick Guide to Writing Great Research Papers‖, Tata McGraw Hills Pvt. Ltd, New Delhi.

Course Code	Course Title						Core/Elective
AD 9002 CE	**Disaster Management**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
- To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
- To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.

Course Outcomes

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

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction
2. and humanitarian response.
3. Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multiple perspectives.
4. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in**.**

UNIT-I

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT-III

Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT-IV

Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-IV

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal Book Company.
2. Sahni, Pardeep (Eds.), "Disaster Mitigation Experiences and Reflections", PHI, New Delhi.
3. Goel S. L., "Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

Course Code	Course Title						Core/Elective
AD 9003 HS	**Sanskrit for Technical Knowledge**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects
- To explore the huge knowledge from ancient Indian literature

Course Outcomes

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

1. Develop passion towards Sanskrit language
2. Decipher the latent engineering principles from Sanskrit literature
3. Correlates the technological concepts with the ancient Sanskrit history.
4. Develop knowledge for the technological progress
5. Explore the avenue for research in engineering with aid of Sanskrit

UNIT-I

Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)

UNIT-II

Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series).

The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).

UNIT-III

Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):

Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower-Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)

UNIT-IV

Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vedic command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.

UNIT-V

Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthi yanthram

Suggested Readings:

1. M Krishnamachariar, History of Classical Sanskrit Literature, TTD Press, 1937.
2. M.R. Kale, A Higher Sanskrit Grammar: For the Use of School and College Students, Motilal Banarsidass Publishers, 2015.
3. Kapail Kapoor, Language, Linguistics and Literature: The Indian Perspective, ISBN- 10: 8171880649, 1994.
4. Pride of India, Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5. Shri Rama Verma, Vedas the source of ultimate science, Nag publishers, 2005.

Course Code	Course Title						Core/Elective
AD 9004 HS	**Value Education**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand the need and importance of Values for self-development and for National development.
- Imbibe good human values and Morals
- Cultivate individual and National character.

Course Outcomes

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

1. Gain necessary Knowledge for self-development
2. Learn the importance of Human values and their application in day to day professional life.
3. Appreciate the need and importance of interpersonal skills for successful career and social life
4. Emphasize the role of personal and social responsibility of an individual for all-round growth.
5. Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.

UNIT-I

Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.

UNIT-II

Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT-III

Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.

UNIT-IV

Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

UNIT-V

Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

Suggested Readings:

1. Chakroborty, S.K., Values & Ethics for organizations Theory and practice‖, Oxford University Press, New Delhi, 1998.
2. Jaya Dayal Goyandaka, Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur, 2017.

Course Code	Course Title						Core/Elective
AD 9011 HS	**Constitution of India and Fundamental Rights**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective and to address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

Course Outcomes

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

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

UNIT-I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT-IV

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT-V

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Readings:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Code	Course Title						Core/Elective
AD 9012 HS	**Pedagogy Studies**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To present the basic concepts of design and policies of pedagogy studies.
- To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessment practices.
- To familiarize various theories of learning and their connection to teaching practice.
- To create awareness about the practices followed by DFID, other agencies and otherresearchers.
- To provide understanding of critical evidence gaps that guides the professional development

Course Outcomes

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

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.
2. Examine the effectiveness of pedagogical practices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Describe the role of classroom practices, curriculum and barriers to learning.
5. Understand Research gaps and learn the future directions.

UNIT-I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT-II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT-III

Evidence on the Effectiveness of Pedagogical Practices: Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT-IV

Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT-V

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

Suggested Readings:

1. Ackers J, Hardman F, Classroom Interaction in Kenyan Primary Schools, Compare‖, 31 (2): 245 – 261, 2001.
2. Agarwal M, Curricular Reform in Schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3. Akyeampong K, Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER), Country Report 1. London: DFID, 2003.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J, Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count? International Journal Educational Development, 33 (3): 272- 282, 2013.
5. Alexander R J, Culture and Pedagogy: International Comparisons in Primary Education, Oxford and Boston: Blackwell, 2001.
6. Chavan M, Read India: A mass scale, rapid, learning to read campaign, 2003.

Course Code	Course Title						Core/Elective
AD 9013 HS	**Stress Management by Yoga**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

The Course will introduce the students to

- Creating awareness about different types of stress and the role of yoga in the management of stress.
- Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
- Prevention of stress related health problems by yoga practice.

Course Outcomes

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

1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas.
5. Improve work performance and efficiency.

UNIT - I

Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT - II

Meaning and Definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT - III

Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress

UNIT - IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT - V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation Techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

Suggested Readings:

1. "Yogic Asanas for Group Training - Part-I", Janardhan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, "Rajayoga or Conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.
3. Nagendra H.R and Nagaratna R, "Yoga Perspective in Stress Management", Swami Vivekananda Yoga Prakashan, Bangalore.

Course Code	Course Title						Core/Elective
AD 9014 HS	**Personality Development Through Life Enlightenment Skills**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes

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

1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

UNIT - I

Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT - II

Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT - III

Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT - IV

Statements of Basic Knowledge - Shrimad Bhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT - V

Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Readings:

1. Srimad Bhagavad Gita, Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

Online Resources: NTPEL: http://nptel.ac.in/downloads/109104115/

Course Code	Course Title						Core/Elective
PC 5251 HV	**Refrigeration Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To familiarize with the fundamentals of refrigeration cycles
- To calculate the COPs of refrigeration cycles
- To comprehend the performance of cooling towers, ice plant, expansion devices
- To analyse the performance of vortex tube, heat pump, air-conditioning law limit
- To understand the pull down characteristics of domestic refrigerator
- To understand the working of ventilation systems

Course Outcomes

After completing this course, the student will be able to:

1. Define and explain the refrigeration cycles
2. Explain the working of ventilation systems
3. Calculate the COPs of refrigeration cycles
4. Comprehend the performance of cooling towers, ice plant, expansion devices
5. Analyse the performance of heat pump
6. To understand the pull down characteristics of domestic refrigerator

List of Experiments:

1. Study and Performance of Vapour Compression Refrigeration Cycle
2. To find performance of Refrigeration Test Rig by using different Expansion Devices
3. To find performance parameters of an Ice Plant
4. To find performance parameters of Vapour Absorption Refrigeration system
5. Performance analysis of Mechanical Heat Pump
6. Study of pull down characteristics of Domestic Refrigerator

Course Code	Course Title						Core/Elective
PC 5252 HV	**Air-Conditioning Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To familiarize with the working of air conditioning systems
- To calculate the COPs of air conditioners
- To comprehend the performance of cooling towers, ice plant, expansion devices
- To analyse the performance of vortex tube, air-conditioning law limit
- To understand the pull down characteristics of domestic refrigerator
- To understand the working of ventilation systems

Course Outcomes

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

1. State the basic concepts and principles of air-conditioning
2. Obtain cooling capacity and coefficient of performance by conducting test on air-conditioning test rig
3. Comprehend the performance of Ventilation Trainer
4. Analyse the performance of vortex tube, air-conditioning law limit
5. Calculate the efficiency of air washer
6. Investigate the pull down characteristics of domestic refrigerator

List of Experiments:

1. Find out the COP and Cooling Capacity of window Air Conditioning System
2. Find out the efficiency of air washer test rig
3. Find out the Humidified efficiency and overall efficiency of the experimental Cooling tower
4. Find the COP, Cooling Capacity and bypass factor of the Air Condition test rig
5. COP of miniature centralized AC unit
6. Performance analysis of Vortex Tube Apparatus
7. Study of performance parameters using Ventilation Trainer

Course Code	Course Title						Core/Elective
PC 5253 HV	**HVAC Systems Design Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To calculate the building heating & cooling loads using appropriate software
- To calculate the duct sizes and cooling tower & chilled water pipe sizes
- To identify and select appropriate air terminal outlets
- To assess Indoor Air Quality using appropriate software
- To prepare the 2D design and working drawings of HVAC systems

Course Outcomes

After completing this course, the student will be able to:

1. List the various software used in the field of HVAC
2. Select appropriate air terminal outlets
3. Use an appropriate software to calculate heating & cooling loads of a building
4. Analyse the various duct sizes and cooling tower / chilled water pipe sizes
5. Assess Indoor Air Quality using appropriate software
6. Design and draft the 2D design and working drawings of HVAC systems

List of Experiments:

1. Understanding the various psychrometric processes on psychrometric chart
2. Simple Heating & Cooling Load Calculations using related software
3. Designing of ducts sizing using related software
4. Chilled water air-conditioning system pipe sizing using related software
5. Selection of air terminal outlets using related software
6. Indoor Air Quality assessment using related software
7. HVAC design and 2D drafting using AutoCAD software
8. Demonstration of the following HVAC design features in Commercial, Residential, & Industrial projects:
    a. Duct design
    b. Coordination with MEP services
    c. Plant room design
    d. Mechanical room design

Course Code	Course Title						Core/Elective
PC 5254 HV	**Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Outcomes

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

1. Develop the habit of referring the journals for literature review.
2. Understand the gist of the research paper.
3. Identify the potential for further scope.
4. Present the work in an efficient manner.
5. Write the documentation in standard format.

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Summary and Conclusions
5. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at least five research papers from **Peer-reviewed** or **UGC recognised** journals.
2. **The seminar report should be in the following order:** Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory. If the student fails to secure minimum attendance as per O.U. rules, the marks awarded in the seminar presentation shall remain void.

Course Code	Course Title						Core/Elective
PC 5255 HV	**Mini Project with Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**4**	**50**	**-**	**2**

Course Outcomes

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

1. Formulate a specific problem and give solution
2. Develop model/models either theoretical/practical/numerical form
3. Solve, interpret/correlate the results and discussions
4. Conclude the results obtained
5. Write the documentation in standard format

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something moreoriginal.
- Mini projects shall have inter-disciplinary/ industry relevance.
- The students can select a mathematical modeling based/Experimental investigations or Numerical modeling
- All the investigations should be clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and reference

Departmental committee: Supervisor and a minimum of two faculty members

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

Course Code	Course Title						Core/Elective
PC 5256 HV	**Major Project Phase – I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	**20**	**100**	-	**10**

Course Outcomes

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

1. Exposed to self-learning various topics.
2. Learn to survey the literature such asbooks, journals and contact resource persons for the selected topic of research.
3. Learn to write technical reports.
4. Develop oral and written communication skills to present.
5. Defend their work in front of technically qualified audience

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The work has to be presented in front of the committee consists of Chairperson-BoS, Osmania University and Head, Supervisor & Project coordinator from the respective Department of the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, Osmania University and Head, Supervisor & Project coordinator from the respective department of the institution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the student regularly.

Course Code	Course Title						Core/Elective
PC 5257 HV	**Major Project Phase – II (Dissertation)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**32**	**-**	**200**	**16**

Course Outcomes

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

1. Use different experimental techniques and will be able to use different software/ computational /analytical tools.
2. Design and develop an experimental set up/ equipment/test rig.
3. Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analysing them.
4. Either work in a research environment or in an industrial environment.
5. Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester - III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, & Head, Osmania University and Supervisor from the Institute.
- The candidate has to be in regular contact with his/her Supervisor / Co- Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS & Head, Osmania University (All together)	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce