

Institute of Engineering and Technology
Dr. Rammanohar Lohia Avadh University, Ayodhya



**Evaluation Scheme with
Syllabus
for
B. Tech 4th Year
Mechanical Engineering
on
Choice Based Credit System
(Effective from the session: 2025-26)**

SSM
DIRECTOR
Institute of Engineering & Technology
Dr. R.M.L. Avadh University
Ayodhya - 224001

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Sept 16, 2025

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EVALUATION SCHEME B.Tech
(MECHANICAL ENGINEERING)

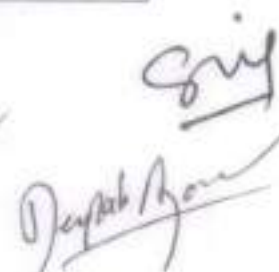
YEAR 4th / SEMESTER VII

S. No.	Subject Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1.		OPEN ELECTIVE COURSE-1	3	0	0	30	20	50		100		150	3
2.		DEPTT ELECTIVE COURSE-1	3	0	0	30	20	50		100		150	3
3.		DEPTT ELECTIVE COURSE-2	3	0	0	30	20	50		100		150	3
4.	MEC 701	CAD/CAM	3	0	0	30	20	50		100		150	3
5.	MEA 702	Automobile Engineering	3	0	0	30	20	50		100		150	3
6.	MEC 7L1	CAD/CAM Lab	0	0	2				25		25	50	1
7.	MEA 7L2	IC Engine & Automobile Lab	0	0	2				25		25	50	1
8.	MET 7L3	Industrial Training	0	0	3				50			50	1
9.	MEP 7L4	Project Part-I	0	0	4				100			100	2
	TOTAL		15	0	11							1000	20

OPEN ELECTIVE COURSE-1		
S. No.	Subject Code	Subject
1.	OE701	Entrepreneurship Development
2.	OE702	Advanced Metal Processes
3.	OE 703	Optimization Method in Engineering
4.	OE 704	*Human Values in Madhyasth Darshan

DEPARTMENTAL ELECTIVE COURSE-1		
S. No.	Subject Code	Subject
1.	MEE 701	Composite Materials
2.	MEE 702	Operation Research
3.	MEE 703	Surface Engineering
4.	MEE 704	Supply Chain Management





DEPARTMENTAL ELECTIVE COURSE-2		
S. No.	Subject Code	Subject
1.	MEE 705	Mechanical System Design
2.	MEE 706	Modelling And Simulation
3.	MEE 707	Automation And Robotics
4.	MEE 708	Project Management

EVALUATION SCHEME

B.Tech(MECHANICAL ENGINEERING)

YEAR 4th/ SEMESTER VIII

S. No.	Subject Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credit
			L	T	P	CT	TA	Total	PS	TE	PE		
1.		OPEN ELECTIVE COURSE-2	3	0	0	30	20	50		100		150	3
2.		DEPTT ELECTIVE COURSE-3	3	0	0	30	20	50		100		150	3
3.		DEPTT ELECTIVE COURSE-4	3	0	0	30	20	50		100		150	3
5.	MEM 801	Total Quality Management	3	0	0	30	20	50				150	3
6.	MEP 8L2	Project Part-II	0	0	12				150		250	400	6
	TOTAL		12	0	12							1000	18

OPEN ELECTIVE COURSE-2		
S. No.	Subject Code	Subject
1.	OE801	Renewable Energy Resources
2.	OE802	Machine Learning
3.	OE803	Micro and Smart Systems
4.	OE804	*Values, Relationship & Ethical Human Conduct-For a Happy & Harmonious Society
DEPARTMENTAL ELECTIVE COURSE-3		
S. No.	Subject Code	Subject
1.	MEE 801	Power Plant Engineering
2.	MEE 802	Advanced Welding Technology
3.	MEE 803	Non-Destructive Testing
4.	MEE 804	Production Planning and Control
DEPARTMENTAL ELECTIVE COURSE-4		
S. No.	Subject Code	Subject
1.	MEE 805	Additive Manufacturing
2.	MEE 806	Unconventional Machining Processes
3.	MEE 807	Theory of Elasticity and Plasticity
4.	MEE 808	Plant Layout and Material Handling

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SEMESTER VII

CAD/CAM

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MEC701

COURSE OBJECTIVES:

1. To teach the role of CAD/CAM in modern design and manufacturing
2. To impart the use of CAD in the design process
3. To impart the use of CAM in the production preparation process
4. Demonstrate the applications and limitations of different CAD/CAM system types

Module I:

Introduction to CAD, Elements of CAD, Essential requirements of CAD, Concepts of integrated CAD/CAM, Necessity & its importance, Engineering Applications Computer Graphics-I CAD/CAM systems, 4(L)

Principles of Computer Graphics:

Computer Graphics-I Graphics Input devices-cursor control Devices, Digitizers, Keyboard terminals, Image scanner, Speech control devices and Touch, panels, Graphics display devices Cathode Ray Tube, Random & Raster scan display, Color CRT monitors, Direct View Storage Tubes, Flat Panel display, Hard copy printers and plotters, Bresenham's circle algorithm. 5(L)

Module II:

Graphics standard & Curves: Standards for computer graphics GKS, PHIGS. Data exchange standards – IGES, STEP – Manipulation of the model - Model storage. 4(L)

Design of curved shapes- Cubic spline – Bezier curve – B-spline –4(L)

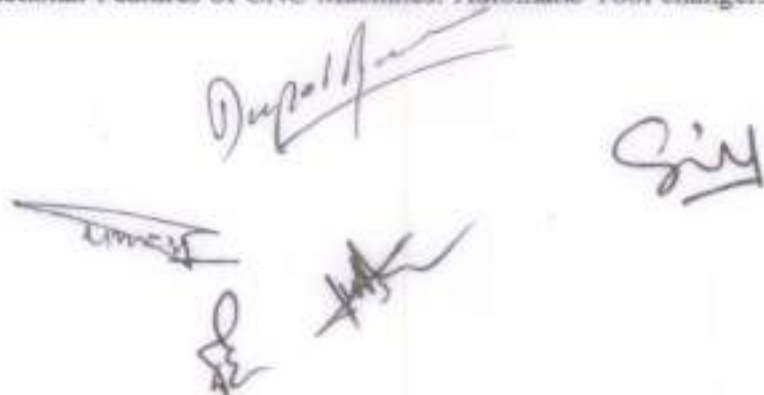
Module III:

Numerical control in CAM:

Definition, Historical background, basic components of NC system, Classification, fundamentals of NC, Procedure, Co-ordinate system, motion control systems, Advantages of NC system; Features of CNC Machine tools, Economics of NC machining centers. 4(L)

Introduction to automation and need and future on NC systems and CAM. Advantage and disadvantages. Features in NC Machines: Difference between ordinary and NC machine tool. 4(L)

Computer Numerical Control-Principle of operation of CNC, Features of CNC, and Development in CNC systems, Adaptive Control, Direct Numerical Control (DNC) Standard Communication Interfaces, Programmable Logic Controllers (PLCs) Communication networks, new development in NC. Constructional Features of CNC Machines: Automatic Tool changers. 5(L)

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Module IV:

NC Part Programming-Manual part programming, computer assisted part programming.
Feed Back Devices: stepping motors, Feedback devices such as encoder, counting devices, Digital to Analog converter and vice versa;
Interpolators- Principle, Digital Differential Analyzer, Linear Interpolator, Circular Interpolator.

5(L)**Module V:**

Control of NC System-Open and closed loops. Automatic control of closed loops with encoder & tachometers. Computer Integrated Manufacturing System- Manufacturing cell, Transfer lines. FMS, CIM concept.

5(L)

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

CO1: Understand the possible applications of the CAD/CAM systems in structure analysis, optimize and virtual engineering.

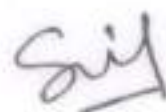
CO2: Demonstrate the basic fundamentals that are used to create, manipulate and analyse Geometric models in a computer graphics.

CO3: To learn about Robot motions, sensors, end effectors Programming, kinematic analysis of robot.

CO4: Explain the basic concepts, features of NC, CNC, DNC machines and machining centres.

Books and References:

1. Chris McMahon and - CAD/CAM - Principle Practice and Manufacturing Management, Jimmie Browne Addison Wesley England, Second Edition, 2000.
2. Dr. Sadhu Singh - Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.
3. P. Radhakrishnan, - CAD/CAM/CIM, New Age International (P) Ltd., New Delhi. S. Subramanian and V. Raju.
4. Groover M.P. and - CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall Zimmers EW. International, New Delhi, 1992.
5. Ibrahim Zeid - CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., Company Ltd., New Delhi, 1992.
6. Mikell P. Groover - Automation, Production Systems and Computer Integrated Manufacturing, Second edition, Prentice Hall of India, 2002.
7. S. Kant Vajpayee - Principles of Computer Integrated Manufacturing, Prentice Hall of India, 1999.
8. David Bed worth - Computer Integrated Design and Manufacturing, TMH, 1998.



AUTOMOBILE ENGINEERING

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MEA 702

Course Objectives:

- 1- To study basics of principles of actual automobilesystems.
- 2- To study importance and features of different systems like axle, differential, brakes, Steering, suspension, and balancing etc
- 3- To study working of various AutomobileSystems.
- 4- To know some modern trends in AutomotiveVehicles.

Module I

Introduction

Basic concept of automobile engineering and general configuration of an automobile. Power and torque characteristics. Rolling air and gradient resistance. Tractive effort. Gear Box. Gear ratio determination.7(L)

Module II

Transmission System:

Requirements Clutches torque converters Over Drives and free wheel Universal joint Differential Gear Mechanism of Rear Axle Automatic transmission steering and front Axel Castor Angel wheel camber and toe-in Toe-out etc steering geometry ackerman mechanism under steer and over steer .8(L)

Module III

Braking system

General requirement road tyre adhesion weight transfer braking ratio. Mechanical brakes hydraulic brakes vacuum and air brakes thermal aspects5(L)

Chasis and suspension system

Loads on the frame strength and stiffness independent front and rear suspension, perpendicular arm type, parallel arm type, dead axis suspension system, live axis suspension system, air suspension & shock absorbers. 5(L)

Module IV

Electrical system:

Types of starting motors, generator regulators, lighting system, ignition system, horn battery etc. 5(L)

Fuel supply system:

Diesel & petrol vehicle system such as fuel injection pump injector & fuel pump, carburetorsetc MPFP. 4(L)

Module V

Emission slandered and pollution control

Indian standard for automotive vehicle-bharat I ,II,III,IV,V and VI norms, fuel quality standards, environmental management system for automotive vehicle, catalytic converters, fuel additives and modern trends in automotive engine efficiency and emission control.



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Introduction to Electric & Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive- trains on energy supplies, Configuration and Performance of Electric Vehicles.

6(L)

Course outcome

CO1	Understand the basic lay-out of an automobile
CO2	Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
CO3	Understand the principles of transmission, suspension, steering and braking systems.
CO4	Understand automotive electronics.
CO5	Study latest developments in automobiles.

Text/Reference books:

1. Crouse, W.H., and Anglin, D.L., Automotive Mechanics, Tata McGraw Hill, New Delhi, 2005.
2. Heitner, J., Automotive Mechanics, Affiliated South West Press, New Delhi, 2000.
3. Narang, G.B., Automobile Engineering, Khanna Publishers, New Delhi, 2001.
4. Kamaraju Ramakrishna, Automobile Engineering, PHI Learning pvt. Ltd., New Delhi-2012

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CAD/CAM LAB

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MEC7L1

List of Experiments: (Total EIGHT Experiments are to be carried out. FOUR Experiments each from CAD and CAM.)

A. CADEXperiments:

1. To study Line Drawing or Circle Drawing experiment.
2. To study Geometric Transformation algorithm experiment for translation/rotation/scaling.
3. To study Design of machine component or other system experiment: Writing and validation of computer program.
4. Understanding and use of any 3-D Modelling Software commands.
5. To study Pro/E/Idea etc, modeling of a machine component.
6. To study FEM for 2 spring system.

B. CAMExperiments:

1. To study the characteristic features of CNC machine.
2. To study G code and M code for part Programming for turning operation.
3. To study Part Programming for drilling operation (point to point) and running on CNC machine.
4. To study Transfer line/Material handling.
5. To study difference between ordinary and NC machine, study or retrofitting.

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A signature in the middle that appears to be "Ankur".
The word "Siri" written in a cursive script.
Below "Siri" is a signature that appears to be "Deepak Singh".
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I.C. ENGINES & AUTOMOBILE LAB

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MEA7L2

Experiments: Say at least 8 experiments out of following in depth and details.

1. Study of four stroke S.I. Engine-
2. Study Four stroke C.I. Engine
3. Study of Valve mechanism.
4. Study of Gear Box.
5. Study of Differential Gear Mechanism of Rear Axle.
6. Study of Steering Mechanism.
7. Study of Automobile Braking System.
8. Study of Chassis and Suspension System.
9. Study of Ignition system of I.C. Engine.
10. Study of Fuel Supply System of S.I. Engines- Carburetor, Fuel Injection Pump and MPFI.
11. Study of Fuel Supply System of C.I. Engines- Injector & Fuel Pump.



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OPEN ELECTIVE-I

ENTREPRENEURSHIP DEVELOPMENT

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OE 701

Course Objective: The students develop and can systematically apply an entrepreneurial way of thinking that will allow them to identify and create business opportunities that may be commercialized successfully.

Module I

Entrepreneurship- definition, growth of small scale industries in developing countries and their positions vis-a-vis large industries; role of small scale industries in the national economy; characteristics and types of small scale industries; demand based and resources based ancillaries and sub-control types. Government policy for small scale industry; stages in starting a small scale industry. 8(L)

Module II

Project identification- assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods. 8(L)

Module III

Accountancy- Preparation of balance sheets and assessment of economic viability, decision making, expected costs, planning and production control, quality control, marketing, industrial relations, sales and purchases, advertisement, wages and incentive, inventory control, preparation of financial reports, accounts and stores studies. 8(L)

Module IV

Project Planning and control: The financial functions cost of capital approach in project planning and control. Economic evaluation, risk analysis, capital expenditures, policies and practices in public enterprises. Profit planning and programming, planning cash flow, capital expenditure and operations. Control off in axial flows, control and communication. 8(L)

Module V

Laws concerning entrepreneur viz, partnership laws, business ownership, sales and income taxes and workman compensation act. Role of various national and state agencies which render assistance to small scale industries. 8(L)

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

CO1	Understand the nature of entrepreneurship
CO2	understand the function of the entrepreneur in the successful, commercial application of innovations



CO3	confirm an entrepreneurial business idea
CO4	identify personal attributes that enable best use of entrepreneurial opportunities
CO5	explore entrepreneurial leadership and management style.

Text books:

1. Forbat, John, "Entrepreneurship" New Age International.
2. Havinal, Veerbhadrappa, "Management and Entrepreneurship" New Age International
3. Joseph, L. Massod, "Essential of Management", Prentice Hall of India

ADVANCED METAL PROCESSES

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OE 702

Course Objectives: :

To introduce the student to processing of structural materials and materials selection for structural applications using advanced metal processes.

Module I:

Introduction to Manufacturing Processes

- a. Discussion inter-relationship of materials and processing with manufacturing
- b. Introduce materials selection criterion
- c. Introduce materials process selection criterion
- d. Briefly discuss important physical and mechanical properties of metals and alloys.
- e. Examples of structural alloys (e.g., ferrous, non-ferrous, refractory metals, superalloys).

Surfaces

- a. Introduce surface finish, wear and lubrication
- b. Surface finish measurement
- c. Wear
- d. Lubrication

Module II:

Casting Processes

- a. Introduce solidification processing of metals and alloys
- b. Solidification
- c. Melting of engineering alloys
- d. Casting of ingot and shapes
- e. Common casting techniques (e.g., mold, Die Casting centrifugal, squeeze, etc)
- f. Advanced casting techniques (e.g., Stir Casting, cooling slope casting of semi-solid etc)

Wrought Processing

- a. Discuss deformation processing and its effect(s) on microstructures and properties
- b. Forging
- c. Rolling
- d. Extrusion

Module III:

Powder metallurgy processes

- a. Discuss design criterion, limitations and advantages of P/M processing

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- b. Powder making techniques
- c. Hot working and fabrication
- d. Near-net and net-shape processing

Module IV:

Coatings

- a. Discuss coatings for improved surface properties
- b. Wear resistance
- c. Environmental resistance

Hybrid processes

- a. Spray forming
- b. Composites

Module V:

3-D printing

- a. Types of Processes
- b. Cura is an open source slicing application for 3D printers.
- c. Application in Casting
- d. Industrial Applications of 3D Printing (Medical, Automotive, Aerospace, etc)
- e. Case Studies

Course Outcomes:

1. To impart knowledge on structural materials and materials selection bulk forming processes.
2. To understand the properties of various advanced casting and forming processes using microstructure analysis.
3. To provide insight into Surface properties, Coating, powder metallurgy and introduce other Hybrid processes.
4. To make the students understand fundamental of casting.
5. Upon Completion of this course, students will be able to illustrate the concept and application of 3D Printing process.

Text / References book:

1. Manufacturing Science – A. Ghosh and AK. Mallik, Affiliated East-West Press
2. Manufacturing Processes for Engineering Materials, - S. Kalpakjian, and Steven R Schmid, Pearson Publication, 5th Edition
3. Fundamental of Modern Manufacturing, MP. Groover, Wiley Publication, 3rd Edition
4. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing by Ian Gibson and David Rosen.
5. Production Technology - R.K. Jain Khanna Publishers.
6. Manufacturing Processes- JP Kaushish, PHI Publication
7. Advances in 3D Printing and Additive Manufacturing Technologies by David Ian Wimpenny and Pulak M Pandey. Understanding Additive Manufacturing, by- Andreas Gebhardt, Hanser
8. Manufacturing Technology Part I and Part II, - PN. Rao, McGraw-Hill
9. Process & Materials of Manufacturing – R.A. Lindburg, Pearson Education.

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OPTIMIZATION METHOD IN ENGINEERING

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OE 703

Course Objective:

Introduction to optimization techniques using both linear and non-linear programming. The focus of the course is on convex optimization though some techniques will be covered for non-convex function optimization too. After an adequate introduction to linear algebra and probability theory, students will learn to frame engineering minima maxima problems in the framework of optimization problems.

Module 1:

Introduction-Optimization Problem Formulation, Design Variables, Constraints, Objective Function, Variable Bounds, Engineering Optimization Problems, Optimization Algorithms. 4(L)

Module 2:

Single Variable Optimization Problems-Optimality Criterion, Bracketing Methods: Exhaustive Search Method, Bounding Phase Method. Region Elimination Methods-Interval Halving Method, Fibonacci Search Method, Golden Section Search Method. Point Estimation Method-Successive Quadratic Estimation Method. Gradient Based Methods-One of the followings-Newton-Raphson Method, Bisection Method, Secant Method, Cubic Search Method. 8(L)

Module 3:

Multivariable Optimization Algorithms-Optimality Criteria, Unidirectional Search, Direct Search Methods: Any two of the followings-Evolutionary optimization method, Simplex Search Method, Hooke-Jeeves pattern search method, Powell's Conjugate Direction Method.

Gradient Based Methods-Cauchy's Steepest Descent Method. Newton's method, Marquardt's Method. Conjugate Gradient Method, Variable-metric Method. 8(L)

Module 4:

Constrained Optimization Algorithms, Kuhn Tucker Conditions, Transformation Methods-Penalty Function Method, Method of Multipliers. Sensitivity analysis. 5(L)

Module 5:

Specialized Algorithms, Integer Programming-Penalty Function Method, Branch and Bound Method., Geometric Programming. 5(L)

Module 6:

Non-Traditional Optimization Algorithms-Genetic Algorithms, Simulated Annealing-Analogy, Algorithm, Application and Optimization in Operation Research: Linear Programming, Transportation Problems, & Assignment. 10(L)

Course outcomes:

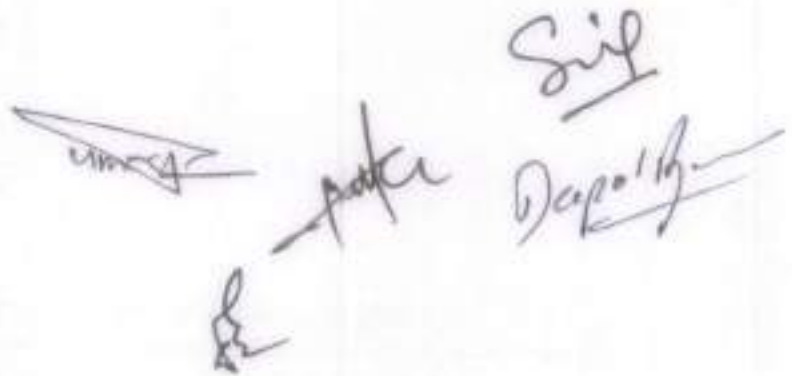
1. understand importance of optimization of industrial process management



2. apply basic concepts of mathematics to formulate an optimization problem
3. analyse and appreciate variety of performance measures for various optimization problems
4. Cast engineering minima/maxima problems into optimization framework.
5. Learn efficient computational procedures to solve optimization problems.
6. Ability to bring together and flexibly apply knowledge to characterise, analyse and solve a wide range of problems

Text/Reference Books:

- 1 Kalyanmoy Deb, 2010. Optimization for engineering design: algorithms and examples. Prentice-Hall of India Private Limited, New Delhi.
- 2 Singiresu S Rao, 2009. Engineering optimization: theory and practice. Fourth Edition, New Age International (P) Limited Publishers, New Delhi.
- 3 A. Ravindran, K. M. Ragsdell, G. V. Reklaitis, 2006. Engineering optimization - methods and applications. Second Edition, John Wiley & Sons, Inc. Andreas Antoniou and Wu-Sheeng Lu, 2007. Practical Optimization: Algorithms and applications, Springer Science+Business Media, LLC

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HUMAN VALUES IN MADHYASTH DARSHAN

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OE 704

Pre requisite : RVE 301/401- Universal Human Values and Professional Ethics

Objectives:

1. To help students understand the basic principles of Madhyasth Darshan
2. To help students understand the existential realities including the human existence through Madhyasth Darshan
3. To help them to see the participation of human beings in the nature/existential realities (i.e. human values) and therefore the human conduct through each one of them
4. To help students apply this understanding to make their living better at different levels- individual, family, society and nature
5. To facilitate the students in applying this understanding in their profession and lead an ethical life

Catalogue Description

Madhyasth Darshan is a new emerging philosophy that describes the existential realities along with its implication in behavior and work at the level of individual as well as society. This philosophy has been propounded by Shri A. Nagraj in seventies.

It is to be kept in mind that Darshan means realization which calls for developing the capacity to see the reality in oneself directly. So, any study of Darshan shall help develop this capacity in the students through proper steps of practices and shall not just provide the information. 8(L)

Module I

Introduction to Madhyasth Darshan and its Basics: Need to study Madhyasth Darshan; introduction, basic formulations of the darshan; the complete expanse of study and the natural outcome of living according to the darshan. 8(L)

Module II

Submergence of Nature in Space: The ever-present existence in the form of nature submerged in space; nature classified into two categories – material and consciousness, and four orders; the form, property, natural characteristic and self organization of the four orders, General direction and process of evolution in the nature/ existence. 8(L)

Module III

Human Being as an indivisible part of Nature:

Human being as an indivisible part of nature; various types (five classes) of human beings; human being in the combination of self and body; purpose of self as realization, prosperity for the body; need of behavior and work for attaining the goals of realization and prosperity. 8(L)

Module IV

Fulfillment of human goal of realization and prosperity: Following natural, social and psychological principles for actualizing the human goal; Form of conducive society and order for

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such practices, study process- achieving realization through self-study and practice while living in such a society (social order).8(L)

Module V

Human Conduct based on Madhyasth Darshan:

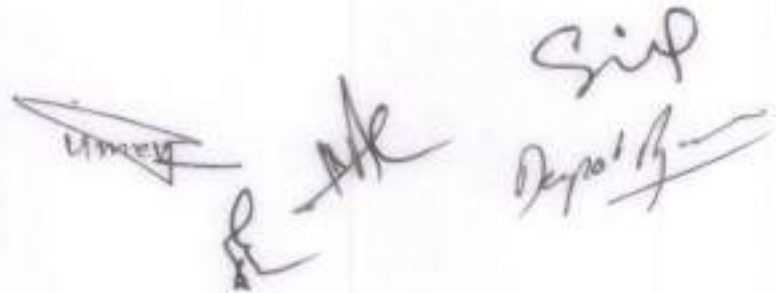
Description of such a realized self, continuity of happiness, peace, satisfaction and bliss through realization, conduct of a realized human being. Possibility of finding solutions to present day problems (such as inequality of rich and poor, man and woman etc.) in the light of it. 8(L)

Text Books:

1. Nagraj, A., "Manav Vyavahar Darshan", Jeevan Vidya Prakashan, 3rd edition, 2003.

References:

1. Nagraj, A., "VyavaharvadiSamajshastra", Jeevan Vidya Prakashan, 2nd edition, 2009.
2. Nagraj, A., "AvartanasheelArthashastra", Jeevan Vidya Prakashan, 1st edition, 1998.

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DEPARTMENTAL ELECTIVE-1

COMPOSITE MATERIALS

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MEE 701

Course Objectives:

1. To make understand the capabilities and limitations of existing materials, processes and property enhancement mechanisms.
2. To understand the fundamentals of composite material strength and its mechanical behavior.
3. To provide opportunity for improvements, select materials and processes to best suit specific applications.
4. To enhance knowledge on processing, interfacial properties and application of composites.
5. To predict the elastic properties of both long and short fiber composites based on the constituent properties.

Module I:

Introduction:

Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. 8(L)

Module II:

Types of Reinforcements/Fibers:

Role and Selection of reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers,

Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres. Material properties that can be improved by forming a composite material and its engineering potential. 8(L)

Module III:

Various types of composites:

Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites. 8(L)

Module IV:

Fabrication methods:

Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament winding, compression moulding, resin transfer casting method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics,

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Bleeder and breather plies, bagging films, maximum stress and strain criteria, Von Mises Yield criterion for isotropic materials.8(L)

Module V:

Testing of Composites and Analysis:

Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Interlaminar shear testing, Fracture testing etc. Analysis of laminated plates- equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.8(L)

Course Outcomes:

On completion of the course, student should be able to;

CO1: Analyze the properties of matrix material, particulates and fibers of polymer, metal and ceramic matrix composites.

CO2: Know the mechanism of how a smart works and selection of a smart material for specific applications.

CO3: Solve numerical problems based on micromechanics of composites.

CO4: Select suitable testing procedures, characterization of composite materials and knowledge of secondary processing of composites.

CO5: Select suitable fabrication processes for fiber reinforced, metal matrix composites and ceramic composites.

Books and References:

1. Materials characterization, Vol. 10, ASM handbook.
2. Mechanical Metallurgy, by G. Dieter, McGrawHill.
3. Analysis and Performance of Fiber Composites, by Agarwal, McGrawHill.
4. Thermal Analysis of Materials, by R.F. Speyer, Marcel Decker.
5. Engineering Mechanics and Composite Materials, by Daniels, Oxford University Press.
6. Material Science and Engineering (SIE) with CD, by Smith, McGrawHill.
7. Gibson R.F. Principles of Composite Material Mechanics, second edition, McGraw Hill, 1994.
8. Engineering Materials: Polymers, Ceramics and Composites, by A.K Bhargava Prentice Hall India.

OPERATIONS RESEARCH

L-T-P

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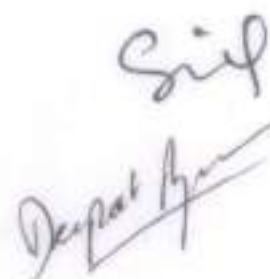
MEE 702

Course Objectives:

1. Impart knowledge of mathematics, basic and applied sciences.
2. Ability to identify, formulate and solve mechanical engineering problems based on data interpretation, design, experiment and analysis of results.
3. Learn effective engineering communication.
4. Ability to work in teams on multi-disciplinary projects in industry and research organizations.
5. Develop awareness of the ethical, professional and environmental implications of work in a global and societal context.







Module I:**Introduction:**

Basic of Operation Research, Origin & development of Operation Research, Applications.

Linear Programming:

Introduction & Scope, Problem formulation, Graphical Method, Simplex methods, primal and dual problem sensitivity analysis.8(L)

Module II:**Transportation Problem:**

Methods of obtaining initial and optimum solution, degeneracy in transportation problems, unbalanced Transportation Problem.4(L)

Assignment Problem:

Methods of obtaining optimum solution, Maximization problem, travelling salesman problem. 4(L)

Module III:**Game Theory:**

Two-person Zero sum game, Solution with/without saddle point, dominance rule, Different methods like Algebraic, Graphical and game problem as a special case of Linear Programming.

Sequencing:

Basic assumptions, n Jobs through 2-3 machines, 2 Jobs on m machines.8(L)

Module IV:

Stochastic inventory models: Single & multi period models with continuous & discrete demands, Service level & reorder policy.

Simulation: Use, advantages & limitations, Monte-Carlo simulation, Application to queuing, inventory & other problems.8(L)

Module V:

Queuing models: Characteristics of Queuing Model, M/M/1 and M/M/S system, cost consideration.

Project management: Basic Concept of network Scheduling, Rules for drawing network diagram, Applications of CPM and PERT techniques in Project planning and control; crashing of operations; resource allocation. 8(L)

Course Outcomes: On completion of the course, student should be able to;

CO1: Define models for linear programming

CO2: Convert the linear variable problems to a mathematical model and depict by graphical method.

CO3: Apply artificial variable technique to solve a linear programming model.

CO4: Compute the minimum cost of transportation by Modi's method and Hungarian method.

CO5: Design a project network diagram and schedule the project activities and duration.

CO6: Illustrate the strategies of different players in a game and find the best strategy by graphical and dominance method.

W. M. S. S.

Dr. A. K. S.

Dr. P. K. S.

Books and References:

1. Operations Research: Principles and Practice, by- Ravindran, Phillips, Solberg, John Wiley & Sons.
2. Principal of Operation Research, by- Harvey M. Wagner, PrenticeHall.
3. Operations Research - An Introduction, by- Hamdy A. Taha, PearsonIndia.
4. Operation Research, by- Wayne L. Winston, ThomsanLearning.
5. Problems in Operations Research by- Prem Kumar Gupta & D.S. Hira, S.Chand.
6. Operations Research, by Jha, McGrawHill.
7. Operation Research, by Yadav & Malik Oxford University Press.

Surface Engineering

L-T-P

3-0-0

MEE 703

Course Objectives:

Understanding of surface structure and surface engineering basics

Understanding basics of wear and corrosion problems

Understanding the contrasts between different group of surface engineering processes

Industrial applications of different surface engineering technique

Module I

Mechanisms of Wear and Metal Cleaning: Basic Mechanisms of wear-abrasive, adhesive wear, contact fatigue, Fretting corrosion, Testing of wear resistance, general cleaning process for ferrous and non ferrous metals and alloys selection of cleaning processes, alkaline cleaning, emulsion cleaning, ultrasonic cleaning., 10(L)

Module II

Thermal Spraying Processes and Electrodeposited Coatings: Thermal spraying materials, characteristics of thermal spray processes, Design for thermally sprayed coatings coating production, spray fused coatings, Principles of electroplating, plasma coating. Advanced Surface treatment processes e.g. Laser surface treatment – Melting, re-melting, texturing, alloying and cladding 10(L)

Module III

Hot Dip Coating and Diffusion Coating: Principles, Surface preparation, Batch coating and continuous coating process, Coating properties and application, Principles of cementation, . Sprayed metal coating, Structure of diffusion coatings, (PVD). 9(L)

Module IV

Non-Metallic Coating Oxide and Conversion Coatings: Plating coating, lacquers, rubbers and elastomers, anodizing Chromating, application to aluminium, magnesium, tin, zinc, cadmium copper and silver, phosphating primers. 6(L)

Module V

Quality Assurance, Testing and Selection of Coatings: The quality plan, design, testing and inspection, thickness and porosity measurement, selection of coatings, industrial applications of engineering coatings. 6(L)

Course Outcomes:

CO1 Understand the importance, need of surface engineering and review past, present and future status of surface engineering.

CO2 Analyze the factors responsible for damage of the surfaces by corrosion, wear, and wear mechanisms.

CO3 Comprehend the laser processing, electrons & ion beam processing of surfaces, to characterize and evaluate coatings.

CO4 Evaluate economics, energy consumption in designing surface engineering processes.

CO5 Student will be able propose surface engineering technique for target applications

REFERENCE/TEXT BOOKS :

1. Engineering Coatings-design and application- S. Grainger, Jaico PublishingHouse.
2. Principles of Metals surface treatment and protection- D. R. Gabe,Pergamon.
3. Electroplating Handbooks- N.V.Parathasarathy, PrenticeHall.
4. Advances in surface treatment- Niku-Lavi,Pergamon.

SUPPLY CHAIN MANAGEMENT

L-T-P

3-0-0

MEE 704

Course Objectives:

To provide an insight on the fundamentals of supply chain strategy, logistics, sourcing and outsourcing supply chain networks, tools and techniques.

Module I:

Introduction to Supply Chain Management, Understanding the Supply Chain. Supply Chain Performance: Competitive and Supply Chain Strategies, achieving Strategic Fit and Scope of Strategic Fit.8(L)

Module II:

Supply Chain Drivers and Metrics: Drivers of Supply Chain Performance, Framework for structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing and Pricing, Case Study: Seven-Eleven Japan Company.8(L)

Module III:

Planning Demand and Supply in a Supply Chain: Demand Forecasting in a Supply Chain, Aggregate Planning in a Supply Chain.
Designing Distribution Networks and Application to E-Business- Role of distribution, factors influencing distribution network design, design options for a distribution network, E- Business and the distribution network.8(L)

Module IV:

Network Design in the Supply Chain- Role of network design in the supply chain, factors influencing network design decisions, framework for network design decisions.
Role of Information Technology in supply chain, coordination in a supply chain, Bullwhip Effect, Effect on performance due to lack of coordination, obstacles to coordination in a supply chain.8(L)

Module V:

Factors influencing logistics and decisions. Benchmarking and performance measurement. 8(L)

Course Outcomes:

CO1: Define structure of supply chain

CO2: Design supply chain configuration

CO3: Analyze the role of Transportation in SCM

Books and References:

1. Supply Chain Management: Strategy, Planning & Operation- Sunil Chopra & Peter Meindle- Pearson Prentice Hall Publication.
2. Logistical Management: The integrated Supply Chain Process- Donald J. Bowersox & David J. Closs- TMH Publication.
3. Supply Chain Management – Martin Christopher.
4. World Class Supply Management: The key to Supply Chain Management- Burt, Dobler and Straling- TMH Publication.
5. Logistics and Supply Management – D K Agarwal – MacMillan Publication
6. Supply Chain Management in the 21st Century- B. S. Sahay- MacMillan Publication.
7. Supply Chain Management: Theories & Practices – R P Mohanty and S. G. Deshmukh- Biztantra Publication.
8. e-Procurement: From Strategy to Implementation- Dale Neef- Prentice Hall Publication.

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DEPARTMENTAL ELECTIVE-2
MECHANICAL SYSTEM DESIGN

L-T-P
3-0-0

MEE 705

Course objectives:

1. Capstone design objectives—assign students a project that will allow them to integrate a majority of their skills acquired in the last four years regarding both engineering science, design, and communication
2. Students will learn and demonstrate both oral and written engineering communication skills
3. Students will consider cost and time constraints (economic considerations) in execution of their design project
4. Students will consider safety, ethical, and other societal constraints in execution of their design projects

Module 1

Engineering process and System Approach:

Basic concepts of systems, Attributes characterizing a system, system types, Application of system concepts in Engineering, Advantages of system approach, Problems concerning systems, Concurrent engineering, A case study-Viscous lubrication system in wire drawing. 4(L)

Problem Formulation:

Nature of engineering problems, Need statement, hierarchical nature of systems, hierarchical nature of problem environment, problem scope and constraint, A case study heating duct insulation system, high speed belt drive system. 4(L)

Module 2

System Theories:

System Analysis, Black box approach, state theory approach, component integration approach, Decision process approach, A case study-automobile instrumentation panel system. 4(L)

System modeling:

Need of modelling, Model types and purpose, linear systems, mathematical modeling, concepts, A case study compound bar system. 4(L)

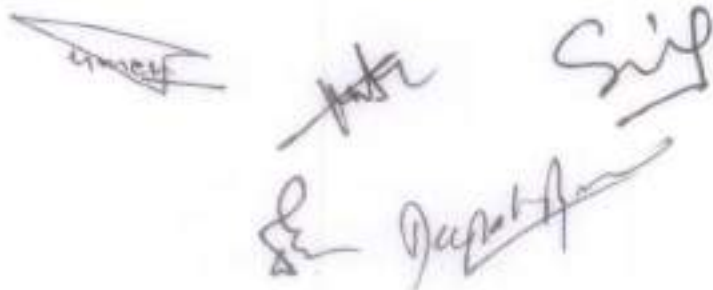
Module 3

Graph Modeling and Analysis:

Graph Modeling and analysis process, path problem, Network flow problem, A case study: Material handling system. 4(L)

Optimization Concepts:

Optimization processes, Selection of goals and objectives-criteria, methods of optimization, analytical, combinational, subjective. A case study: aluminum extrusion system. 3(L)



Module 4

System Evaluation:

Feasibility assessment, planning horizon, time value of money, financial analysis, a case study: Manufacture of maize starch system.4(L)

Calculus Method for Optimization:

Model with one decision variable, model with two decision variables, model with equality constraints, model with inequality constraints, A case study: Optimization of an insulation system. 4(L)

Module 5

Decision Analysis:

Elements of a decision problem, decision making, under certainty, uncertainty risk and conflict probability, density function, expected monetary value, Utility value, Baye's theorem, A case study: Installation of machinery. 4(L)

System Simulation: Simulation concepts, simulation models, computer application in simulation, spread sheet simulation, Simulation process, problem definition, input model construction and solution, limitation of simulation approach, a case study: Inventory control in production plant.5(L)

Course Outcomes: - At the end of the course, the student will be able to:

CO1 – Develop an understanding on the use the material data obtained from Standard mechanical testing methods for structural design applications.

CO2 –Analyse the structural response behavior by breaking the response of structure into axial, bending and torsional deformation modes.

CO3 – Design simple connections for use in structural mechanics.

CO4 –Analyse thermal behavior of structural members.

CO5 – Develop an understanding of experimental mechanics techniques through the use of strain gauge measurements and photo elastic experiments.

Books/References:-

1. Design and Planning of Engineering systems:- DD Reredith, K V Wong, K W Woodhead and RR Worthman, Prentice Hall Inc., Eaglewood cliffs, NewJerse.
2. Design Engineering:- JR Dixon, TMH, NewDelhi.
3. An introduction to Engineering Design Method:- V Gupta and PN Murthy, TMH, NewDelhi.
4. Engineering Design:- Robert Matousck, Blackie and son Ltd.Glasgow
5. Optimization Techniques:- SSRao

MODELLING AND SIMULATION

L-T-P

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MEE 706

Course Objective:

The overall aim of the course is to provide an understanding of methods, techniques and tools for modeling, simulation and performance analysis of complex systems

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Module I:

Bioinformatics objectives and overviews, Interdisciplinary nature of Bioinformatics, Data integration, Data analysis, Major Bioinformatics databases and tools. Metadata: Summary & reference systems, finding new type of data online. Molecular Biology and Bioinformatics: Systems approach in biology, Central dogma of molecular biology, problems in molecular approach and the bioinformatics approach, overview of the bioinformatics applications. 8(L)

Module II:

Basic chemistry of nucleic acids, Structure of DNA, Structure of RNA, DNA Replication, Transcription-Translation, Genes- the functional elements in DNA, Analyzing DNA, DNA sequencing. Proteins: Amino acids, Protein structure, Secondary, Tertiary and Quaternary structure, Protein folding and function, Nucleic Acid-Protein interaction. 8(L)

Module III:

Perl Basics, Perl applications for bioinformatics- Bio Perl, Linux Operating System, mounting/unmounting files, tar, gzip / gunzip, telnet, ftp, developing applications on Linux OS, Understanding and Using Biological Databases, Overview of Java, CORBA, XML, Web deployment concepts. 8(L)

Module IV:

Genome, Genomic sequencing, expressed sequence tags, gene expression, transcription factor binding sites and single nucleotide polymorphism. Computational representation of molecular biological data storage techniques: databases (flat, relational and object oriented), and controlled vocabularies, general data retrieval techniques: indices, Boolean search, fuzzy search and neighbouring, application to biological data warehouses. 8(L)

Module V:

Macromolecular structures, chemical compounds, generic variability and its connection to clinical data. Representation of patterns and relationships: sequence alignment algorithms, regular expressions, hierarchies and graphical models, Phylogenetics. BLAST. 8(L)

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

CO1- Describe the role of important elements of simulation and modeling.

CO2- Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.

CO3- Simulation technique is used to construct and execute goal-driven problem.

CO4- Interpret the model and apply the results to resolve critical issues in a real world environment.

CO5- Understanding and Using the Biological Databases

Books and References:

1. D E Krane & M L Raymer, "Fundamental concepts of Bioinformatics", Pearson Education.
2. Rastogi, Mendiratta, Rastogi, "Bioinformatics Methods & applications, Genomics, Proteomics & Drug Discovery" PHI, New Delhi.

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3. Shubha Gopal et.al. "Bioinformatics: with fundamentals of genomics and proteomics", Mc GrawHill.
4. O'Reilly, "Developing Bio informatics computer skills", CBS.
5. Simulation Model Design & execution by Fishwick, Prentice Hall, 1995.
6. Discrete event system simulation by Banks, Carson, Nelson and Nicol.
7. Averill M. Law, W. David Kelton, "Simulation Modelling and Analysis", TMH.
8. Forsdyke, "Evolutionary Bioinformatics", Springer.

AUTOMATION AND ROBOTICS

L-T-P

3-0-0

MEE 707

Course Objective:

1. To study the various parts of robots and fields of robotics.
2. To study the various kinematics and inverse kinematics of robots.
3. To study the Euler, Lagrangian formulation of Robot dynamics.
4. To study the trajectory planning for robot.
5. To study the control of robots for some specific applications.

Module I:

Automation:

Definition, Advantages, goals, types, need, laws and principles of Automation. Elements of Automation. Fluid power and its elements, application of fluid power, Pneumatics vs. Hydraulics, benefit and limitations of pneumatics and hydraulics systems, Role of Robotics in Industrial Automation. 8(L)

Module II:

Manufacturing Automation:

Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multi model and mixed model production lines. Programmable Manufacturing Automation CNC machine tools, Machining centres. 8(L)

Module III:

Robotics:

Definition, Classification of Robots - Geometric classification and Control classification, Laws of Robotics, Robot Components, Coordinate Systems, Power Source. Robot anatomy, configuration of robots, joint notation schemes, work volume, manipulate or kinematics, position representation, forward and reverse transformations, homogeneous transformations in robot kinematics, D-H notations. 8(L)

Module IV:

Robot Drives and Power Transmission Systems:



Robot drive mechanisms: Hydraulic / Electric / Pneumatics, servo & stepper motor drives, Mechanical transmission method: Gear transmission, Belt drives, Rollers, chains, Links, Linear to Rotary motion conversion, Rotary-to-Linear motion conversion. 8(L)

Module V:

Robot Simulation:

Methods of robot programming, Simulation concept, Off-line programming, advantages of offline programming. 2(L)

Robot Applications:

Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Limitation of usage of robots in processing operation. 6(L)

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

- CO1-Explain the basic concepts of working of robot
- CO2-Analyze the function of sensors in the robot
- CO3-Write program to use a robot for a typical application
- CO4-Use Robots in different applications

Books and References:

1. An Introduction to Robot Technology, by CoifetChirroza, KoganPage.
2. Robotics for Engineers, by Y. Koren, McGrawHill.
3. Robotic: Control, Sensing, Vision and Intelligence, by Fu, McGrawHill.
4. Introduction to Industrial Robotics, by Nagrajan, PearsonIndia.
5. Robotics, by J.J. Craig, Addison-Wesley.
6. Industrial Robots, by Groover, McGrawHill.
7. Robotic Engineering - An Integrated Approach : Richard D. Klafter ThomasA.
8. Robots & Manufacturing Automation, by Asfahl, Wiley.

PROJECT MANAGEMENT

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MEE 708

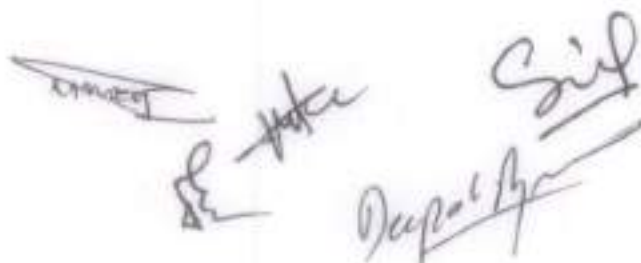
Courseobjective:

To enable the students to implement project management knowledge, processes, lifecycle andthe embodied concepts, tools and techniques in order to achieve projectsuccess.

Module I

Project Management Concepts

Introduction, project characteristics, taxonomy of projects, project identification and formulation.Establishing the project and goals. Nature & context of project management; phases of PM, Aframework for PM issues, PM as a conversion process, project environment &



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complexity. Organizing human resources, organizing systems & procedures for implementation. Project direction. 8(L)

Module II

Project Organization & Project Contracts

Introduction, functional organization, project organization, matrix organization, modified matrix organization, pure project organization, selection of project organization structure, project breakdown structures, project contracts, types of contracts, types of payments to contractors. 8(L)

Module III

Project Appraisal & Cost Estimation

Introduction, technical appraisal, commercial appraisal, economic appraisal, financial appraisal, management appraisal, social cost/benefit analysis, project risk analysis. Cost analysis of the project, components of capital cost of a project, modern approach to project performance analysis. 8(L)

Module IV

Project Planning & Scheduling

Introduction to PERT & CPM, planning and scheduling networks, time estimation, determination of critical path, CPM model, event slacks & floats, PERT model, expected time for activities, expected length of critical path, calculating the project length and variance, PERT & CPM cost accounting systems, lowest cost schedule, crashing of networks, linear programming formulation of event oriented networks, updating of networks, LOB technique. 8(L)

Module V

Modification & Extensions of Network Models

Complexity of project scheduling with limited resources, resource leveling of project schedules, resource allocation in project scheduling - heuristic solution. Precedence networking - examples with algorithm, decision networks, probabilistic networks, computer aided project management essential requirements of PM software, software packages for CPM. Enterprise-wide PM, using spreadsheets for financial projections. 8(L)

Course outcomes:

After learning the course the students should be able:

CO1	To make them understand the concepts of Project Management for planning to execution of projects
CO2	To adapt projects in response to issues that arise internally and externally.
CO3	To Interact with team and stakeholders in a professional manner, respecting differences, to ensure a collaborative project environment.
CO4	To Utilize technology tools for communication, collaboration, information management, and decision support.

Books and References :

1. Project Management by Harvey Maylor, Pearson India
2. Project Management by Choudhury, McGraw Hill
3. Project Management by K. Nagarajan

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4. Project Management: A Systems Approach to Planning, Scheduling and Controlling, by Kerzner, Willey

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SEMESTER VIII

TOTAL QUALITY MANAGMENT

L-T-P

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MEM 801

Course Objective:

1. Develop an understanding on the necessary information and skills needed to manage, control and improve quality practices in the organizations through TQM philosophy.
2. Explain the four revolutions in management thought processes.
3. Apply the reactive and proactive improvement methodologies for problem solving in organizations.
4. Demonstrate the importance of team work in problem solving processes.
5. Define the business excellence models implemented in various organizations.

Module I:

Quality Concepts:

Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design.

Control on Purchased Product:

Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure.

Manufacturing Quality:

Methods and Techniques for manufacture, Inspection and control of product, Quality in sales and services, Guarantee, analysis of claims. 8(L)

Module II:

Quality Management:

Organization structure and design, Quality function, decentralization, Designing and fitting organization for different types products and company, Economics of quality value and contribution, Quality cost, optimizing quality cost. 4(L)

TQM Principles:

Leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection. 4(L)

Module III:

Tools and Techniques:

Seven QC tools (Histogram, Check sheet, Ishikawa diagram, Pareto, Scatter diagram, Control chart, flow chart).

Control Charts:

Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts, P-charts and C-charts. 8(L)

Module IV:

Defects Diagnosis and Prevention:

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Defect study, identification and analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.8(L)

Module V:

ISO and its concept of Quality Management:

Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors, Auditing, Taguchi method, JIT in some details.8(L)

Course Outcomes: At the end of the course, the student will be able to;

CO1 - Evaluate the principles of quality management and to explain how these principles can be applied within quality management systems.

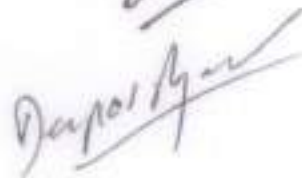
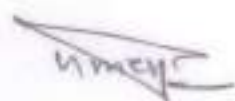
CO2 - Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.

CO3 - Critically appraise the organisational, communication and teamwork requirements for effective quality management

CO4 - Critically analyse the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans

Books and References:

1. Total Quality Management, by Dale H. Besterfield, Pearson India.
2. Beyond Total Quality Management, Greg Bounds, McGrawHill.
3. Besterfield D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
4. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
5. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
6. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.
7. Total Quality Management by Mukherjee, P.N.
8. TQM in New Product manufacturing, H. G. Menon, McGrawHill.



OPEN ELECTIVE-2

RENEWABLE ENERGY RESOURCES

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OE 801

Course Objective:

1. You have profound knowledge in a special field such as solar energy, storage, smartgrid.
2. You are able to use laboratories and emulators of renewable energy systems to analyze relevant issues.
3. You should be used to working in interdisciplinary groups.

Module I

Introduction: Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. **Solar Cells:** Theory of solar cells. Solar cell materials, solar cell array, solar cell power plant, limitations. 8(L)

Module II

Solar Thermal Energy: Solar radiation, flat plate collectors and their materials, applications and performance, focussing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations. 8(L)

Module III

Geothermal Energy: Resources of geothermal energy, thermodynamics of geothermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations.

Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations.

Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations. 8(L)

Module IV

Thermo-electrical and thermionic Conversions: Principle of working, performance and limitations. **Wind Energy:** Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. Performance and limitations of energy conversion systems. 8(L)

Module V

Bio-mass: Availability of bio-mass and its conversion theory.

Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations.

Wave and Tidal Wave: Principle of working, performance and limitations. **Waste Recycling Plants.** 8(L)

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Course Outcomes: At the end of the course, the student will be able to:

CO1 - Ability to recognize the need of renewable energy technologies and their role in the Greece and world energy demand.

CO2 - Knowledge of the operating principles of renewable energy production from various renewable sources

CO3 - Ability to compare the advantages and disadvantages of various renewable energy technologies and propose the best possible energy conversion system for a particular location.

Text books:

1. Raja et al, "Introduction to Non-Conventional Energy Resources" Scitech Publications.
2. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006.
3. M.V.R. Koteswara Rao, "Energy Resources: Conventional & Non-Conventional" BSP Publications, 2006.
4. D.S. Chauhan, "Non-conventional Energy Resources" New Age International.
5. C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.
6. Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.

MACHINE LEARNING

L T P

3 0 0

OE 802

Course Objectives:

Students will try to learn:

1. To introduce students to the basic concepts and techniques of Machine Learning.
2. To become familiar with ANN methods, classification methods, clustering methods.
3. To become familiar with Dimensionality reduction Techniques.

Module I

Introduction – Well defined learning problems, Designing a Learning System, Issues in Machine Learning;

The Concept Learning Task -General-to-specific ordering of hypotheses, Find-S, List then eliminate algorithm, Candidate elimination algorithm, Inductive bias 8(L)

Module II

Decision Tree Learning - Decision tree learning algorithm-Inductive bias- Issues in Decision tree learning;

Artificial Neural Networks –Perceptrons, Gradient descent and the Delta rule, Adaline, Multilayer networks, Derivation of backpropagation rule Backpropagation Algorithm Convergence, Generalization; 8(L)

Module III

Evaluating Hypotheses: Estimating Hypotheses Accuracy, Basics of sampling Theory, Comparing Learning Algorithms;

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Bayesian Learning: Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm; 8(L)

Module IV

Computational Learning Theory: Sample Complexity for Finite Hypothesis spaces, Sample Complexity for Infinite Hypothesis spaces, The Mistake Bound Model of Learning;

Instance-Based Learning – k-Nearest Neighbour Learning, Locally Weighted Regression, Radial basis function networks, Case based learning; 8(L)

Module V

Genetic Algorithms: an illustrative example, Hypothesis space search, Genetic Programming, Models of Evolution and Learning; Learning first order rules sequential covering algorithms- General to specific beam search-FOIL; REINFORCEMENT LEARNING - The Learning Task, Q Learning; 8(L)

Course Outcomes:

Students will be able to:

- CO1. Gain knowledge about basic concepts of Machine Learning
- CO2. Identify machine learning techniques suitable for a given problem
- CO3. Solve the problems using various machine learning techniques
- CO4. Apply Dimensionality reduction techniques.
- CO5. Design application using machine learning techniques.

Text books:

1. Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
2. Ethem Alpaydin, —Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004.
3. Stephen Marsland, —Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
4. Bishop, C., Pattern Recognition and Machine Learning. Berlin: Springer-Verlag.

MICRO AND SMART SYSTEMS

LTP3

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OE 803

Course Objective: Understand Microsystems versus MEMS, Analyze micro sensors, actuators, systems and smart materials, Evaluate Micromachining technologies, To learn Modeling of solids in, Analysis Integration of micro and smart systems.

Module I

Introduction, Why miniaturization?, Microsystems versus MEMS, Why microfabrication?, smart materials, structures and systems, integrated Microsystems, applications of smart materials and Microsystems. 8(L)

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Module II

Micro sensors, actuators, systems and smart materials: Silicon capacitive accelerometer, piezoresistive pressure sensor, conductometric gas sensor, an electrostatic combo-drive, a magnetic microrelay, portable blood analyzer, piezoelectric inkjet print head, micromirror array for video projection, smart materials and systems. 8(L)

Module III

Micromachining technologies: silicon as a material for micro machining, thin film deposition, lithography, etching, silicon micromachining, specialized materials for Microsystems, advanced processes for micro fabrication. 8(L)

Module IV

Modeling of solids in Microsystems: Bar, beam, energy methods for elastic bodies, heterogeneous layered beams, bimorph effect, residual stress and stress gradients, poisson effect and the anticlastic curvature of beams, torsion of beams and shear stresses, dealing with large displacements, In-plane stresses, Modelling of coupled electromechanical systems: electrostatics, Coupled Electro-mechanics: statics, stability and pull-in phenomenon, dynamics. Squeezed film effects in electromechanics. 8(L)

Module V

Integration of micro and smart systems: integration of Microsystems and microelectronics, microsystems packaging, case studies of integrated Microsystems, case study of a smart-structure in vibration control. Scaling effects in Microsystems: scaling in: mechanical domain, electrostatic domain, magnetic domain, diffusion, effects in the optical domain, biochemical phenomena. 8(L)

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

CO1	Understand the Why miniaturization?, Microsystems versus MEMS, Why micro fabrication.
CO2	Design Silicon capacitive accelerometer, piezo-resistive pressure sensor, conductometric gas sensor.
CO3	Realize silicon as a material for micro machining, thin film deposition, lithography, etching, silicon micromachining.
CO4	Understand bar, beam, energy methods for elastic bodies, heterogeneous layered beams, bimorph effect, residual stress and stress gradients, poisson effect and the anticlastic curvature of beams
CO5	Understand integration of Microsystems and microelectronics, microsystems packaging, case studies of integrated Microsystems

Text books:

I. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat and V. K. Atre, "Micro and smart systems", Wiley India, 2010.

Signatures:
Srinivas
Deepak Kumar

VALUES, RELATIONSHIP & ETHICAL HUMAN CONDUCT-FOR A HAPPY & HARMONIOUS SOCIETY

LTP300
OE 804

Pre-requisites-for this subject only those faculty will teach these courses who had done the FDP for these courses.

Course Objectives:

1. To help the students to understand the importance and types of relationship with expressions.
2. To develop the competence to think about the conceptual framework of undivided society as well as universal human order.
3. To help the students to develop the exposure for transition from current state to the undivided society and universal human order.

Course Methodology:

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. It is free from any dogma or set of do's and don'ts related to values.
3. It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated and encouraged to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation.
4. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student leading to continuous self-evolution.
5. This self-exploration also enables them to critically evaluate their preconditioning and present beliefs.

Module I

Introduction to the course: Basic aspiration of a Human Being and program for its fulfillment, Need for family and relationship for a Human Being, Human-human relationship and role of behavior in its fulfillment, Human-rest of Nature relationship and role of work in its fulfillment, Comprehensive Human Goal, Need for Undivided Society, Need for Universal Human Order, an appraisal of the Current State, Appraisal of Efforts in this Direction in Human History. 10(L)

Module II

Understanding Human-Human Relationship & its fulfillment: Recognition of Human-Human Relationship, Recognition of feelings in relationship, Established Values and Expressed Values in Relationship, interrelatedness of feelings and their fulfillment, Expression of feelings, Types of relationship and their purpose, mutual evaluation in relationship, Meaning of justice in relationship, Justice leading to culture, civilization and Human Conduct. 8(L)

Module III

Justice from family to world family order: Undivided Society as continuity and expanse of Justice in behavior - family to world family order, continuity of culture and civilization, Universal Order on the basis of Undivided Society, Conceptual Framework for Universal human order, Universal Human Order as continuity and expanse of order in living: from family order to world family order, a conceptual framework for universal human order. 8(L)

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Dr. P. S. Srinivasan
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Module IV

Program for Ensuring Undivided Society and Universal Human Order: Education – Sanskar, Health – Sanyam, Production-work, Exchange – storage, Justice-preservation.6(L)

Module V

Human Tradition: Scope and Steps of Universal Human Order, Human Tradition (Ex. Family order to world family order), Steps for transition from the current state, Possibilities of participation of students in this direction, Present efforts in this direction, Sum up.8(L)

Text books:

1. A Foundation Course in Human Values and Profession Ethics (Text Book and Teachers' Manual), R. R. Gaur, R. Asthana, G. P. Bagaria (2010), Excel Books, New Delhi.
2. Avartansheel Arthshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India.
3. An Appeal by the Dalai Lama to the World: Ethics Are More Important Than Religion, Dalai Lama XIV, 2015.
4. Economy of Permanence – (a quest for social order based on non-violence), J. C. Kumarappa (2010), Sarva-Seva-Sangh-Prakashan, Varansi, India.
5. Energy and Equity, Ivan Illich (1974), The Trinity Press, Worcester & HarperCollins, USA.
6. Human Society, Kingsley Davis, 1949.
7. Hind Swaraj or, Indian home rule Mohandas K. Gandhi, 1909.
8. Integral Humanism, Deendayal Upadhyaya, 1965.
9. Lohiya Ke Vichar, Lok Bharti, Rammanohar Lohiya, 2008.
10. Manav Vyavahar Darshan, A. Nagraj, Divya Path Sansthan, Amarkantak, India.
11. Manaviya Sanvidhan, A. Nagraj, Divya Path Sansthan, Amarkantak, India.
12. Samadhanatmak Bhautikvad, A. Nagraj, Divya Path Sansthan, Amarkantak, India.
13. Small Is Beautiful: A Study of Economics as if People Mattered, E. F. Schumacher, 1973, Blond & Briggs, UK.
14. Slow is Beautiful, Cecile Andrews (<http://www.newsociety.com/Books/S/Slow-is-Beautiful>)
15. Sociology Themes and Perspectives, Harper Collins; EIGHT edition (2014), Martin Holborn and Peter Langley, 1980.
16. Samagrakranti: Jaya Prakash Narayan's philosophy of social change, Siddharth Publications Renu Sinha, 1996.
17. Science & Humanism – towards a unified worldview, P. L. Dhar & R. R. Gaur (1990), Commonwealth Publishers, New Delhi.
18. Vyavaharvadi Samajshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India.
19. Vyavahatmak Janvad, A. Nagraj, Divya Path Sansthan, Amarkantak, India.
20. The Communist Manifesto, Karl Marx, 1848.
21. Toward a True Kinship of Faiths: How the World's Religions Can Come Together Dalai Lama XIV, 2011.

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DEPARTMENTAL ELECTIVE-3

POWER PLANT ENGINEERING

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3 0 0

MEE 801

Course Objectives:

1. Describe sources of energy and types of powerplants
2. Analyze different types of steam cycles and estimate efficiencies in a steam powerplant
3. Describe basic working principles of gas turbine and diesel engine power plants. Define the performance characteristics and components of such powerplants
4. List the principal components and types of nuclear reactors.
5. Evaluate cycle efficiency and performance of a gas cooled reactor powerplant
6. Classify different types of coupled vapor cycles and list the advantages of combined cycles powerplant

Module I

Introduction

Power and energy, sources of energy, review of thermodynamic cycles related to power plants, fuels and combustion calculations. 3(L)

Load estimation, load curves, various terms and factors involved in power plant calculations. Effect of variable load on power plant operation, Selection of power plant unit. 2(L)

Power plant economics and selection

Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection. 3(L)

Module II

Steam power plant

General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant. 8(L)

Module III

Diesel power plant

General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, Lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant. 3(L)

Gas turbine power plant

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Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant. 5(L)

Module IV

Nuclear power plant

Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants. 3(L)

Hydro electric station Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation and maintenance, hydro systems, interconnected systems. 4(L)

Non Conventional Power Plants

Introduction to non-conventional power plants (Solar, wind, geothermal, tidal) etc. 2(L)

Module V

Electrical system

Generators and generator cooling, transformers and their cooling, bus bar, etc. 2(L)

Instrumentation

Purpose, classification, selection and application, recorders and their use, listing of various control rooms. 3(L)

Pollution

Pollution due to power generation 2(L)

Course Outcomes:

On successful completion of the course, the student will be able to,

- CO 1. Summarize the layout and components in a power plant.
- CO 2. Enumerate and classify the types of power plants available.
- CO 3. Recognize the steam cycles on pressure - volume and temperature diagram.
- CO 4. Outline the scenario of entire business of power plants along with performance parameters, load curves and tariff calculations.
- CO 5. Relate and couple the different thermodynamic cycles to improve efficiency and to reduce pollution.
- CO 6. Extend their knowledge to power plant economics and environmental hazards

Books and References:

- 1. Power Plant Engineering, by F.T. Morse, Affiliated East-West Press Pvt.Ltd.
- 2. Power Plant Engineering by Hedge, Pearson India.
- 3. Power Plant Technology, by Wakil, McGrawHill.
- 4. Power Plant Engineering by P.K. Nag, Tata McGrawHill.
- 5. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub.House.
- 6. Power Plant Engineering by Gupta, PHI India.
- 7. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
- 8. Power Plant Engineering, Mahesh Verma, Metropolitan Book Company Pvt.Ltd.

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ADVANCED WELDING TECHNOLOGY

L-T-P
3-0-0
MEE 802

Course Objectives:

1. To understand the working principle, advantages, disadvantages of electroslag, electrogas welding, thermit welding.
2. The student gains information on different solid-state welding processes.
3. To understand the working principle, weld characteristics and process parameters of high energy beam welding.
4. To understand the process of thermal cutting of materials, brazing and soldering.
5. To understand the concept about underwater welding, welding in space and welding metallurgy.

Module I:

Introduction: Welding as compared with other fabrication processes, Importance and application of welding, classification of welding processes, Health & safety measures in welding.

Welding Power Sources: Basic characteristics of power sources for various arc welding processes, Transformer, rectifier and generators.

Physics of Welding Arc: Welding arc, arc initiation, voltage distribution along the arc, arc characteristics, arc efficiency, heat generation at cathode and anode, Effect of shielding gas on arc, isotherms of arcs and arc blow.

Metal Transfer: Mechanism and types of metal transfer in various arc welding processes. 9(L)

Module II:

Welding Processes:

Manual Metal Arc Welding (MMAW), TIG, MIG, Plasma Arc, Submerged Arc Welding, Electro gas and Electroslag, Flux Cored Arc Welding, Resistance welding, Friction welding, Brazing, Soldering and Braze welding processes, Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding, Friction Stir Welding, Underwater welding & Microwavewelding. 8(L)

Module III:

Heat Flow Welding:

Calculation of peak temperature; Width of Heat Affected Zone (HAZ); cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention. 8(L)

Module IV:

Repair & Maintenance Welding:

Hardfacing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

Weldability: Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and aluminium. Micro & Macro structures in welding. 8(L)

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Module V:

Weld Design:

Types of welds & joints, Joint Design, Welding Symbols, weld defects, Inspection/testing of welds, Introduction to Welding Procedure Specification & Procedure Qualification Record.7(L)

Course Outcomes: On completion of the course, student should be able to;

CO1:Differentiate the mechanism, working principle and process characteristics of electroslog, electro gas welding and thermit welding.

CO2:know the working principle, process characteristics, of friction welding, friction stir welding, ultrasonic welding, adhesive boning, explosion welding and diffusion bonding.

CO3:Describe the mechanism, working principle and process characteristics of high energy beam welding.

CO4:Differentiate between soldering and brazing, their techniques, advantages and limitations, applications. And also decide best cutting techniques for a particular application and their limitations.

CO5:Describe working principle and process characteristics of underwater welding processes, welding in space. And weldability of carbon steel, stainless steel & aluminum. Hot & cold cracking phenomenon, weld defects, causes and their remedies.

Books and References:

1. Welding and Welding Technology, by- Richard L. Little, McGraw Hill Education.
2. Welding Principals and Practices, by- Edwards R. Bohnart, McGraw Hill Education.
3. Welding Engineering and Technology, by- R. S. Parmar, Khanna Publishers.
4. Welding Technology Fundamentals by William. A. Bowditch.
5. Welding Technology by N K Srinivasan.
6. Welding Engineering and Technology by R S Parmar.
7. Welding Handbooks (Vol. I & II).

NON-DESTRUCTIVE TESTING

L-T-P

3-0-0

MEE 803

Course Objective: To impart knowledge in various methods of Non Destructive Testing. Overview the concepts, principles, and methods employed for NDT of structures and materials.

Module I:

Introduction:

Scope and advantages of NDT, Comparison of NDT with Destructive Testing, some common NDT methods used since ages, Terminology, Flaws and Defects, Visual inspection, Equipment used for visual inspection. Ringing test, chalk test (oil whitening test). Uses of visual inspection tests in detecting surface defects and their interpretation, advantages & limitations of visual inspection.8(L)

Unit-II:

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Tests:

Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques, Test stations, Advantages, types of penetrants and developers, Zygo test, Illustrative examples and interpretation of defects.

Magnetic particle Inspection – scope and working principle, Ferro Magnetic and Nonferromagnetic materials, equipment & testing. Advantages, limitations Interpretation of results, DC & AC magnetization, Skin Effect, use of dye & wet powders for magna glow testing, different methods to generate magnetic fields, Applications. 9(L)

Module III:**Radiographic methods:**

Introduction to electromagnetic waves and radioactivity, various decays, Attenuation of electromagnetic radiations, Photo electric effect, Rayleigh's scattering (coherent scattering), Compton's scattering (Incoherent scattering), Pair production, Beam geometry and Scattering factor.

X-ray radiography: principle, equipment & methodology, applications, types of radiations and limitations. γ -ray radiography – principle, equipment., source of radioactive materials & technique, advantages of γ -ray radiography over X-ray radiography Precautions against radiation hazards. Case Study - casting and forging. 9(L)

Module IV:**Ultrasonic testing methods:**

Introduction, Principle of operation, Piezoelectricity. Ultrasonic probes, CRO techniques, advantages, Limitation & typical applications. Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements. Case Study – Ultrasonography of human body. 8(L)

Module V:**Special NDT Techniques:****Eddy Current Inspection:**

Principle, Methods, Equipment for ECT, Techniques, Sensitivity, advanced ECT methods. Application, scope and limitations, types of Probes and Case Studies. Introduction to Holography, Thermography and Acoustic emission Testing. 6(L)

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

CO1	Understand the basic principles , techniques, equipment, applications and limitations of various NDT methods
CO2	Understand various NDT methods such as Visual, Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Eddy Current
CO3	Understand the applications and limitations of NDT methods and techniques and codes
CO4	Understand how to select of appropriate NDT methods.
CO5	aware the developments and future trends in NDT

Books and References:

1. Non-Destructive Testing and Evaluation of Materials, by- Prasad, McGraw Hill Education.

2. Practical Non-destructive Testing, by- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Woodhead Publishing.
3. Non-Destructive Testing Techniques, by- Ravi Prakash, New Age International.
4. Nondestructive Testing Handbook, by Robert C. McMaster, American Society for Nondestructive.
5. Introduction to Nondestructive Testing: A Training Guide, by- Paul E. Mix, Wiley.
6. Electrical and Magnetic Methods of Non-destructive Testing, by- J. Blitz, Springer.
7. Practical non destructive testing by Raj, Baldev.
8. Basics of Non-Destructive Testing, by Lari & Kumar, KATSON Books.

Production Planning and Control

L-T-P
3-0-0
MEE 804

Module I

INTRODUCTION

Objectives and benefits of planning and control, Functions of production control, Types of production, job- batch and continuous, Product development and design, Marketing aspect, Functional aspects, Operational aspect, Durability and dependability aspect aesthetic aspect.

Module II

WORK STUDY

Method study, basic procedure, Selection, Recording of process, Critical analysis, Development - Implementation - Micro motion and memo motion study,

Work measurement - Techniques of work measurement, Time study, Production study, Work sampling, Synthesis from standard data, Predetermined motion time standards.

Module III

PRODUCT PLANNING AND PROCESS PLANNING

Product planning, Extending the original product information, Value analysis, Problems in lack of product planning, Process planning and routing, Pre requisite information needed for process planning, Steps in process planning, Quantity determination in batch production, Machine capacity, balancing, Analysis of process capabilities in a multi product system.

Module IV

PRODUCTION SCHEDULING

Production Control Systems, Loading and scheduling, Master Scheduling, Scheduling rules, Gantt charts, Basic scheduling problems,

Line of balance, Flow production scheduling, Batch production scheduling,

Module V

PRODUCTION SEQUENCING

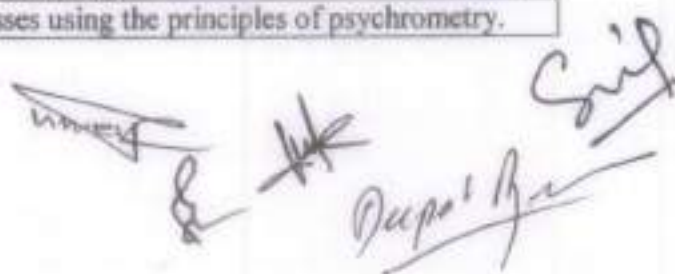
Product sequencing - Production Control systems-Periodic batch control-Material requirement planning, Kanban, Dispatching, Progress reporting and expediting, Manufacturing lead time,

Profit consideration- Standardization, Simplification & specialization, Break even analysis- Economics of a new design.

Course outcomes:

After learning the course the students should be able to:

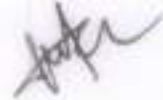
CO 1	Analyze air-conditioning processes using the principles of psychrometry.
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CO 2	Evaluate cooling and heating loads in an air-conditioning system.
CO 3	Analyze thermal distribution technique through heat exchangers, AC and its various types and advantages
CO 4	Analyze the optimum method of designing parts of turbomachinery
CO 5	Understand and solve the optimization problem for single variable and multivariable using the classical optimization technique.

Books and References:

1. Thermal Environment Engg. by Kuhen, Ramsey & Thelked.
2. Refrigeration & Air Conditioning - By C.P. Arora, McGrawHill
3. Refrigeration & Air Conditioning - By Manohar Prasad, NewAge
4. Heating, Ventilating and Air Conditioning - By Mc Quiston, Parker & Spitler
5. Refrigeration & Air Conditioning Data Book - Manohar Prasad, NewAge
6. ASHRAE Hand Book of Fundamentals - ASHRAE
7. Refrigeration & Air Conditioning - Stoecker & Jones, Mc GrawHill
8. Design of High Efficiency Turbomachinery and Gas Turbine by Wilsonm and Korakianitis, PHI, India
9. Turbines compressors and Fans by Yahaya, Mc GrawHill
10. Heat Transfer Equipment Design by Shah, CRC Press
11. Thermal System Design and Optimization by Balaji, Ane Books Pvt Ltd





DEPARTMENTAL ELECTIVE-4

ADDITIVE MANUFACTURING

L-T-P

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MEE 805

Course Objectives: This course enables the students:

1. To learn the basic principle of additivemanufacturing.
2. To understand importance of additive manufacturing and itsapplications.
3. To acquire knowledge, techniques and skills to select relevant additive manufacturingprocess for the fabrication of theobject.
4. To explore the potential of additive manufacturing in different industrialdomains.

Module I:

Introduction:

History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines,

Direct and Indirect Processes: Prototyping, Manufacturing and Tooling.

Layer Manufacturing Processes: Polymerization, Sintering and Melting, Extrusion, Powder-Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing and Bio plotter.8(L)

Module II:

Development of Additive Manufacturing Technology:

Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems. Generalized Additive Manufacturing Process Chain; The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design ofAM.8(L)

Module III:

Additive Manufacturing Processes:

Vat Photopolymerization, Materials, Reaction Rates, Photopolymerization Process Modelling, Scan Patterns, **Powder Bed Fusion Processes:**Material, Powder Fusion Mechanism, Process Parameters and Modelling, powder Handling,

Extrusion Based System:Basic principles, plotting and Path Control, Bio extrusion, Other Systems,

Material Jetting: Materials, Material Processing Fundamentals, Material Jetting Machines,

Binder Jetting:Materials, Process Variations, BJ Machines,

Sheet laminationProcesses:Materials, Ultrasonic Additive Manufacturing,

Directed Energy Deposition Processes: General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing- Structure-Properties Relationships,

Direct Write Technologies:Ink-Based DW, laser Transfer DW, Thermal Spray DW, Beam Deposition DW, Liquid Phase Direct Deposition, Hybrid Technologies.10(L)

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Module IV:

Design & Software Issues:

Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AM-based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM. 4(L)

Software Issue for Additive Manufacturing: Introduction, Preparation of CAD Models: The STL file, Problem with STL file, STL file Manipulation, Beyond the STL file, Additional Software to Assist AM. 4(L)

Module V:

Material Design & Quality Aspects:

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities. 4(L)

Applications:

Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others. 2(L)

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

CO1 Able to define the various process used in Additive Manufacturing/Rapid Prototyping

CO2 Able to analyse and select suitable process and materials used in Additive Manufacturing/Rapid Prototyping.

CO3 Able to identify, analyse and solve problems related to Additive Manufacturing/Rapid Prototyping.

CO4 Able to apply knowledge of additive manufacturing for various real-life problems

Books and References:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by- Ian Gibson, D Savid W. Rosen, Brent Stucker, Springer.
2. Additive Manufacturing, by- Amit Bandyopadhyay, Susmita Bose, CRC Press.
3. Rapid Prototyping: Principles and Applications, by - Chee Kai Chua, Kah Fai Leong, Chu Sing Lim.
4. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing by Ian Gibson and David Rosen.
5. Additive Manufacturing of Metals: From Fundamental Technology to Rocket Nozzles, Medical Implants, and Custom Jewelry (Springer Series in Materials Science) by John O Milewski.
6. Additive Manufacturing: Advanced Manufacturing Technology in 3d Print Deposit by Sabrie Soloman.
7. Advances in 3D Printing and Additive Manufacturing Technologies by David Ian Wimpenny and Pulak M Pandey.
8. Understanding Additive Manufacturing, by- Andreas Gebhardt, Hanser.

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UNCONVENTIONAL MACHINING PROCESSES

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MEE 806

Course Objectives:

1. Understand the need and importance of non-traditional machining methods and process selection.
2. Gain the knowledge to remove material by thermal evaporation, mechanical energy process.
3. Apply the knowledge to remove material by chemical and electro chemical methods.
4. Analyze various material removal applications by unconventional machining process.

Module I:

INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES

Unconventional machining Process – Need – classification – merits, demerits and applications. Abrasive Jet Machining – Water Jet Machining – Abrasive Water Jet Machining - Ultrasonic Machining. (AJM, WJM, AWJM and USM). Working Principles – equipment used – Process parameters – MRR- Applications.

Module II:

THERMAL AND ELECTRICAL ENERGY BASED PROCESSES

Electric Discharge Machining (EDM) – Wire cut EDM – Working Principle-equipments-Process Parameters-Surface Finish and MRR- electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Applications. Laser Beam machining and drilling, (LBM), plasma, Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types - Beam control techniques –Applications.

Module III:

CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES

Chemical machining and Electro-Chemical machining (CHM and ECM)- Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR-Applications. Principles of ECM- equipments-Surface Roughness and MRR Electrical circuit-Process Parameters- ECG and ECH - Applications.

Module IV:

ADVANCED NANO FINISHING PROCESSES

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing, magneto rheological finishing, magneto rheological abrasive flow finishing their working principles, equipments, effect of process parameters, applications, advantages and limitations.

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Module V:

RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES

Recent developments in non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Comparison of non-traditional machining processes.

COURSE OUTCOMES (CO's)

- CO 1. Compare non-traditional machining, classification, material applications in material removal process
- CO 2. Summarize the principle and processes of abrasive jet machining.
- CO 3. Understand the principles, processes and applications of thermal metal removal processes.
- CO 4. Identify the principles, processes and applications of EBM.
- CO 5. Understand the principles, processes and applications of Plasma Machining.

Text Books: 1. Fundamentals of Machining Processes-Conventional and non – conventional processes/Hassan Abdel – Gawad El-Hafy/CRC Press-2016.

References:

- 1. Modern Machining Process / Pandey P.C. and Shah H.S./TMH.
- 2. New Technology / Bhattacharya A/ the Institution of Engineers, India 1984.
- 3. Non Traditional Manufacturing Processes / Benedict/

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THEORY OF ELASTICITY AND PLASTICITY

L-T-P

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MEE 807

Course Objective:

1. To impart knowledge of Principal stresses and strains.
2. To develop analytical skills of solving problems using plain stress and plain strain.
3. To impart knowledge of engineering application of plasticity.

Module I

Elasticity: Analysis of stress and strain, Definition of stress and strain at a point, Equilibrium and compatibility equations, Transformation of stress and strain at a point Principal stresses and strains: Stress and strain invariants, hydrostatic and deviator stress strains.

Module II

Plane stress and plane strain: - Simple two dimensional problems in Cartesian and polar coordinates, Airy's stress function in rectangular and polar coordinates.

Module III

Stress-strain relations for linearly elastic solids: Generalized Hooke's law, Solution of axisymmetric problems, stress concentration due to presence of a circular hole, Elementary problems of elasticity in three dimensions.

Module IV

Torsion: St. Venant's approach-Prandtl's approach - Membrane analogy - Torsion of thin walled open and closed sections.

Module V

Plasticity: Physical Assumptions - Yield criteria - Tresca and VonMises criterion of yielding, plastic stress strain relationship, Elastic plastic problems in bending. Some engineering applications of elasticity and plasticity.

Course Outcomes:

1. The students shall be able to demonstrate the application of plane stress and plane strain in a given situation.
2. The student will demonstrate the ability to analyze the structure using plasticity.
3. To impart the knowledge of stress-strain relations for linearly elastic solids, and Torsion.

TEXT BOOKS

1. Timoshenko, S. and Goodier J.N. "Theory of Elasticity", 2nd Edition, McGraw Hill Book Co, 2001.
2. Sadhu Singh, "Theory of Elasticity", 3rd Edition, Khanna Publishers, 2003.

REFERENCES:

1. Chen W.F. and Han D.J. "Plasticity for structural Engineers", 1st Edition, Springer-Verlag, 2000.
2. Irving H. Shames and James, M. Pitarresi. "Introduction to Solid Mechanics", 4th Edition, Prentice Hall of India Pvt. Ltd., 2000.



PLANT LAYOUT AND MATERIAL HANDLING

L-T-P
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MEE 808

Course Objective:

1. Get the basics of process layout & product layout.
2. Get the idea about the material handling systems.
3. Learn about the different types material handling methods , paths equipments and functions.

Module I

Introduction: Criteria, Strategies/Tactics, Sustainability and Eco-Efficiency in Facility Design, Basic Planning, Alternative Machine Arrangements, Flow Lines, Location Models, Act/Building Details, Aisles and Security, Storage, Shipping and Receiving, Offices, Specialized Areas, 8(L)

Module II

Workstations, Unit Loads & Containers, Conveyors, Vehicles, Lifting Devices, Workstation Material Handling, Ethics in Facility Design Facilities design procedure and planning strategies, Production, activity and materials flow analysis, Space requirements and personnel services design considerations. 8(L)

Module III

Layout construction techniques: systematic layout planning; activity relationship analysis, pairwise exchange, graph-based construction algorithmic.

Material Handling: Material handling principles; material handling equipment and material handling systems. 8(L)

Module IV

Computerized Layout and Analytical Methods: ALDEP, CORELAP, CRAFT, BLOCPLAN, etc.

Warehouse operations: function, storage operations.

Manufacturing operation: JIT, TQM, AM, CIM, SCM, Facility systems,

Quantitative models: Layout model, waiting line, AS/RS, simulation model, etc. 8(L)

Module V

Assessment and evaluation of layout alternatives Projects, Use Spiral software to practice plant layout design, Apply mathematical and engineering techniques such as systematic layout planning approach, quantitative model, cost estimate to solve practical facility layout problem.

8(L)

Course Outcomes:

CO1. Able to get the basics of process layout & product layout

CO2. Able to get the idea about the material handling systems

CO3. Able to know about the different types material handling methods, paths equipments and functions.

Books and References:

1. Plant Layout and Material Handling, by- James M. Apple, John Wiley & Sons.
2. Plant Layout and Material Handling, by- Fred E. Meyers, Prentice Hall.

[Handwritten signatures and initials at the bottom of the page]

3. Facility Layout and Location: An Analytical Approach, by Richard L. Francis, Pearson India.
4. Plant Layout and Material Handling, by- B. K. Aggarwal, Jain Brothers.
5. Plant Layout and Material Handling, by- S. C. Sharma, Jain Brothers.
6. Materials Handling Handbook, by- Raymond A. Kulwiec, John Wiley & Sons.
7. Plant Design and Economics, by- Peters, McGraw Hill Education.
8. Purchasing and Material Management, by- Gopalakrishnan, McGraw Hill Education.

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