INSTITUTE OF ENGINNERING AND TECHNOLOGY LUCKNOW

(An Autonomous Constituent Institute of Dr. A.P.J. Abdul Kalam Technical University, Lucknow)

Evaluation Scheme & Syllabus

For

B. Tech. Fourth Year

(Mechanical Engineering)

On

Choice Based Credit System

[Effective from the Session: 2019-20]

SEVENTH SEMESTER									
Sl.No.	**Subject Code**	**Subject Name**	**Department**	**L-T-P**	**Th/Lab Marks**	**Sessional**		**Total**	**Credit**
					ESE	**CT**	**TA**		
1		OPEN ELECTIVE COURSE-1	Other Deptt.	3-0-0	70	20	10	100	3
2		DEPTT ELECTIVE COURSE-3	Core Deptt.	3-0-0	70	20	10	100	3
3		DEPTT ELECTIVE COURSE-4	Core Deptt.	3-1-0	70	20	10	100	4
4	RME701	CAD/CAM	Core Deptt.	3-1-0	70	20	10	100	4
5	RME702	Automobile Engineering	Core Deptt.	3-0-0	70	20	10	100	3
6	RME751	CAD/CAM Lab	Core Deptt.	0-0-2	50		50	100	1
7	RME752	IC Engine & Automobile Lab	Core Deptt.	0-0-2	50		50	100	1
8	RME753	INDUSTRIAL TRAINING	Core Deptt.	0-0-3			100	100	2
9	RME754	PROJECT-1	Core Deptt.	0-0-6			200	200	3
	TOTAL				**450**	**100**	**450**	**1000**	**24**

DEPARTMENTAL ELECTIVE-3	
Sub.Code	**Subject Name**
RME070	Composite Materials
RME071	Power Plant Engineering
RME072	Supply Chain Management
RME073	Additive Manufacturing

DEPARTMENTAL ELECTIVE-4	
S.Code	**Subject Name**
RME075	Operation Research
RME076	Modelling &Simmulation
RME077	Computational Fluid Dynamics
RME078	Automation & Robotics

EIGHT SEMESTER									
Sl.No.	**Subject Code**	**Subject Name**	**Department**	**L-T-P**	**Th/Lab Marks**	**Sessional**		**Total**	**Credit**
					ESE	**CT**	**TA**		
1		OPEN ELECTIVE COURSE-2	Other Deptt.	3-0-0	70	20	10	100	3
2		DEPTT ELECTIVE COURSE-5	Core Deptt.	3-1-0	70	20	10	100	4
3		DEPTT ELECTIVE COURSE-6	Core Deptt.	3-0-0	70	20	10	100	3
4	RME851	SEMINAR	Core Deptt.	0-0-3			100	100	2
5	RME852	PROJECT-2	Core Deptt.	0-0-12	350		250	600	12
	TOTAL				**560**	**60**	**380**	**1000**	**24**

DEPARTMENTAL ELECTIVE-5	
Sub.Code	**Subject Name**
RME080	Non-Destructive Testing
RME081	Advance Welding
RME082	Thermal Turbo Machine
RME083	Energy Conservation &Management

S.Code **MOOC Subject Name**
RME084 Industrial Safety Engineering.

DEPARTMENTAL ELECTIVE-6	
S.Code	**Subject Name**
RME085	Total Quality Management
RME086	Gas Dynamics & Jet Propulsion
RME087	Design & Transmission System
RME088	Theory of Elasticity.

S.Code **MOOC Subject Name**
RME089 Manufacturing of Composites.

SEMESTER-VII

CAD/CAM

L-T-P
3-1-0

UNIT-I:

Principles of Computer Graphics:

Point plotting, drawing of lines, Bresenham's circle algorithm.

Transformation in Graphics:

Co-ordinate system used in Graphics and windowing, view port, views.

2D transformations – rotation, scaling, translation, mirror, reflection, shear - homogeneous transformations – concatenation.

3D Transformation – Perspective Projection – Technique (Description of techniques only).

Geometric Modelling:

Classification of Geometric Modelling – Wire frame, Surface and Solid Modelling, applications – representation of curves and surfaces – Parametric form.

Design of curved shapes- Cubic spline – Bezier curve – B-spline – Design of Surfaces - features of Surface Modelling Package – Solid Primitives, CSG.

B-rep and description of other modelling techniques like Pure primitive instancing, cell decomposition, spatial occupancy enumeration, Boolean Operations (join, cut, intersection), Creating 3D objects from 2D profiles (extrusion, revolving etc).

UNIT-II:

Graphics standard & Data storage:

Standards for computer graphics GKS, PHIGS. Data exchange standards – IGES, STEP - Manipulation of the model - Model storage.

Finite Element Modelling:

Introduction, Mesh Generation – mesh requirements.

Semi-Automatic Methods- Node-based approach, Region based approach, Solid-modelling-based methods.

Fully Automatic Methods- Element-based approach, Application, Mesh Refinements using Isoperimetric Finite Elements, Meshing in high gradient areas, Transition Regions. Sub modelling Concept.

An overview of modelling software's like PRO-E, CATIA, IDEAS, SOLID EDGE etc.

UNIT-III:

CAM:

Scope and applications – NC in CAM – Principal types of CNC machine tools and their construction features – tooling for CNC – ISO designation for tooling – CNC operating system – FANUC, SINUMERIK – LINUMERIK.

Programming for CNC machining – coordinate systems – manual part programming – computer assisted part programming – CNC part programming with CAD system.

Material handling in CAM environment:

Types – AGVS – AS/RS – Swarf handling and disposal of wastes – single and mixed mode assembly lines – quantitative analysis of assembly systems.

UNIT-IV:

Robotics:

Classification and specification – drive and controls – sensors - end effectors - grippers- tool handling and work handling – machine vision – robot programming concepts – case studies in assembly.

Quality Function Deployment:

Process Planning – CAPP – Variant and Generative systems- Concurrent Engineering and Design for Manufacturing.
Advanced manufacturing Planning Computer Aided Production Planning and Control – Aggregate production planning and master production schedule – MRP – MRP II – ERP - Capacity planning.

UNIT-V:

Rapid prototyping:

Need for rapid prototyping, Basic principles and advantages of RP, General features and classifications of different RP techniques with examples.
Introduction to three representative RP techniques: Fusion Deposition Modelling, Laminated Object Manufacturing and Stereo-lithography.

Flexible manufacturing cells:

Systems – characteristics – economics and technological justification – planning, installation, operation and evaluation issues – role of group technology and JIT in FMS – typical case studies future prospects.

Books and References:

1. Chris Mcmahon and - CAD/CAM – Principle Practice and Manufacturing Management,Jimmie Browne Addision Wesley England, Second Edition,2000.
2. Dr.Sadhu Singh - Computer Aided Design and Manufacturing, Khanna Publishers, NewDelhi, Second Edition,2000.
3. P.Radhakrishnan, - CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.S.Subramanayanand V.Raju.
4. Groover M.P. and - CAD/CAM; Computer Aided Design and Manufacturing, Prentice HallZimmers 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 IntegratedManufacturing, Second edition, Prentice Hall of India, 2002.
7. S.Kant Vajpayee - Principles of Computer Integrated Manufacturing, Prentice Hall ofIndia, 1999.
8. David Bed worth - Computer Integrated Design and Manufacturing, TMH, 1998.

AUTOMOBILE ENGINEERING

L-T-P
3-1-0

UNIT-I:
Introduction:
Basic concepts of Automobile Engineering and general configuration of an automobile, Powerand Torque characteristics. Rolling, air and gradient resistance. Tractive effort. Gear Box. Gearratio determination.

UNIT-II:
Transmission System:
Requirements. Clutches. Toque converters. Over Drive and free wheel, Universal joint.Differential Gear Mechanism of Rear Axle. Automatic transmission, Steering and Front Axle.Castor Angle, wheel camber & Toe-in, Toe-out etc... Steering geometry. Ackerman mechanism,Understeer and Oversteer. Hotchkiss drive and Torque tube drive.

UNIT-III:
Braking System:
General requirements, Road, tyre adhesion, weight transfer, Braking ratio. Mechanical brakes,Hydraulic brakes. Vacuum and air brakes. Thermal aspects.Antilock braking system(ABS), electronic brake force distribution (EBD) and traction control.

Chassis and Suspension System:
Loads on the frame, Strength and stiffness, Independent front & rear suspension, Perpendiculararm type, Parallel arm type, Dead axle suspension system, Live axis suspension system,Airsuspension & shock absorbers.

UNIT-IV:
Electrical System:
Types of starting motors, generator & regulators, lighting system, Ignition system, Horn, Batteryetc.

Fuel Supply System:
Diesel & Petrol vehicle system such as Fuel Injection Pump, Injector & Fuel Pump, Carburettoretc. MPFI.

UNIT-V:
Emission standards and pollution control:
Indian standards for automotive vehicles-Bharat I and II, Euro-I and Euro-II norms, fuel qualitystandards, environmental management systems for automotive vehicles, engine emissioncontrol by 3-way catalytic converter system, fueladditives and modern trends in automotive engine efficiency and emission control.

Alternative Energy Sources:
Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogenfuels in automobiles, modifications needed, performance, combustion & emissioncharacteristics of alternative fuels in SI and CI engines, Electric and Hybrid vehicles,application of Fuel Cells. Prevention maintenance and overhauling.

Books and References:
1. Automotive Engineering- Hietner.
2. Automobile Engineering - Narang.
3. Automobile Engineering –TTTI, Pearson India.
4. Automotive Mechanics- Crouse.

5. Automobile Engineering - Newton and Steeds.
6. Automobile Engineering –Ramakrishna, PHI, India.
7. Automobile Engineering - Kripal Singh.
8. Kirpal Singh, Automobile Engineering, 7th ed., Standard Publishers, New Delhi, 1997.

CAD/CAM LAB

L-T-P
0-0-2

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

A. CAD Experiments:

1. Line Drawing or Circle Drawing experiment: Writing and validation of computer program.
2. Geometric Transformation algorithm experiment for translation/rotation/scaling: Writing and validation of computer program.
3. 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. Pro/E/Idea etc. Experiment: Solid modelling of a machine component.
6. Writing a small program for FEM for 2 spring system and validation of program or using a FEM Package.
7. Root findings or curve fitting experiment: Writing and validation of computer program.
8. Numerical differentiation or numerical integration experiment: Writing and validation of computer program.

B. CAM Experiments:

1. To study the characteristic features of CNC machine.
2. Part Programming (in word address format) experiment for turning operation (including operations such as grooving and threading) and running on CNC machine.
3. Part Programming (in word address format or ATP) experiment for drilling operation (point to point) and running on CNC machine.
4. Part Programming (in word address format or ATP) experiment for milling operation (contouring) and running on CNC machine.
5. Experiment on Robot and programs.
6. Experiment on Transfer line/Material handling.
7. Experiment on difference between ordinary and NC machine, study or retrofitting.
8. Experiment on study of system devices such as motors and feedback devices.
9. Experiment on Mechatronics and controls.

I.C. ENGINES & AUTOMOBILE LAB

L-T-P
0-0-2

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

1. Performance Analysis of Four stroke S.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
2. Determination of Indicated H.P. of I.C. Engine by Morse Test.
3. Performance Analysis of Four stroke C.I. Engine- Determination of indicated and brake thermal efficiency, specific fuel consumption at different loads, Energy Balance.
4. Study & experiment on Valve mechanism.
5. Study & experiment on Gear Box.
6. Study & experiment on Differential Gear Mechanism of Rear Axle.
7. Study & experiment on Steering Mechanism.
8. Study & experiment on Automobile Braking System.
9. Study & experiment on Chassis and Suspension System.
10. Study & experiment on Ignition system of I.C. Engine.
11. Study & experiment on Fuel Supply System of S.I. Engines- Carburettor, Fuel Injection Pump and MPFI.
12. Study & experiment on Fuel Supply System of C.I. Engines- Injector & Fuel Pump.
13. Study & experiment on Air Conditioning System of an Automobile.
14. Comparative study of technical specifications of common small cars (such as Maruti Swift, Hyundai i20, Chevrolet Aveo, Tata Indica, Ford Fusion etc.
15. Comparative study & technical features of common scooters & motorcycles available in India.
16. Visit of an Automobile factory.
17. Visit to a Modern Automobile Workshop.
18. Experiment on Engine Tuning.
19. Experiment on Exhaust Gas Analysis of an I.C. Engine.

DEPARTMENTAL ELECTIVE-3

COMPOSITE MATERIALS

L-T-P
3-0-0

UNIT-I:
Introduction:
Classifications of Engineering Materials, Concept of composite materials, Matrixmaterials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosetsand Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc.

UNIT-II:
Types of Reinforcements/Fibers:
Role and Selection of reinforcement materials, Types offibres, 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 acomposite material and its engineering potential.

UNIT-III:
Various types of composites:
Classification based on Matrix Material: Organic Matrixcomposites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-CarbonComposites, Metal matrix composites (MMC), Ceramic matrix composites (CMC);Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer(FRP) Composites, Laminar Composites, Particulate Composites.

UNIT-IV:
Fabrication methods:
Processing of Composite Materials: Overall considerations, Autoclavecuring, Other Manufacturing Processes like filament welding, compression moulding, resintransplantmethod, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrixperforms, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peelplies, release films and fabrics, Bleeder and breather plies, bagging films, maximum stress and strain criteria, Von Mises Yield criterion for isotropic materials.

UNIT-V:
Testing of Composites and Analysis:
Mechanical testing of composites, tensile testing, Compressive testing,Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.Analysis of laminated plates- equilibrium equations of motion, energy formulation, staticbending analysis, buckling analysis, free vibrations, natural frequencies.

Books and References:

1. Materials characterization, Vol. 10, ASM hand book.
2. Mechanical Metallurgy, by G. Dieter, McGraw Hill.
3. Analysis and Performance of Fiber Composites, by Agarwal, McGraw Hill.
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, McGraw Hill.
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.

POWER PLANT ENGINEERING

L-T-P
3-0-0

UNIT-I:

Introduction:

Power and energy, sources of energy, review of thermodynamic cycles related to power plants,fuels and combustion calculations.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 units.Power plant economics and selectionEffect of plant type on costs, rates, fixed elements, energy elements, customer elements andinvestor's profit; depreciation and replacement, theory of rates. Economics of plant selection,other considerations in plant selection.

UNIT-II:

Steam power plant:

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

UNIT-III:

Diesel power plant:

General layout, Components of Diesel power plant, Performance of diesel power plant, fuelsystem, lubrication system, air intake and admission system, supercharging system, exhaustsystem, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant,Comparative study of diesel power plant with steam power plant.

Gas turbine power plant:

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 andmaintenance, Combined cycle power plants, Site selection of gas turbine power plant, Integrated Gasifierbased Combined Cycle (IGCC) systems.

UNIT-IV:

Nuclear power plant:

Layout and subsystems of nuclear power plants, BoilingWater Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, PressurizedHeavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metalcooled reactors, safety measures for nuclear power plants.

Hydroelectric and Non-Conventional Power Plant:

Hydroelectric power plants, classification, typical layout and components, principles of wind,tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

UNIT-V:

Electrical system:

Generators and generator cooling, transformers and their cooling, bus bar, etc.

Energy Saving and Control:

Energy, economic and environmental issues, power tariffs, load distribution parameters, loadcurve, capital and operating cost of different power plants, pollution control technologiesincluding waste disposal options for coal and nuclear plants.

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, McGraw Hill.
4. Power Plant Engineering by P.K. Nag, Tata McGraw Hill.
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.

SUPPLY CHAIN MANAGEMENT

L-T-P
3-0-0

UNIT-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.

UNIT-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.

UNIT-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.

UNIT-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.

UNIT-V:
Factors influencing logistics and decisions.
Benchmarking and performance measurement.

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 – Maretin 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.

ADDITIVE MANUFACTURING

L-T-P
3-0-0

UNIT-I:

Introduction:

History and Advantages of Additive Manufacturing, Distinction Between AdditiveManufacturing and CNC Machining, Types of Additive Manufacturing Technologies,Nomenclature of AM Machines, **Direct and Indirect Processes:**Prototyping, Manufacturingand Tooling.

Layer Manufacturing Processes: Polymerization, Sintering and Melting, Extrusion, Powder-Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing andBio plotter.

UNIT-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 AdditiveManufacturing, Variation from one AM Machine to Another, Metal System, Maintenance ofEquipment, Material Handling Issue, Design of AM.

UNIT-III:

Additive Manufacturing Processes:

Vat Photopolymerization, Materials, Reaction Rates, Photopolymerization Process Modelling,Scan Patterns, **Powder Bed Fusion Processes;** Material, Powder Fusion Mechanism, ProcessParameters and Modelling, powder Handling, **Extrusion Based System;** Basic principles,plotting and Path Control, Bio extrusion, Other Systems, **Material Jetting;** Materials, MaterialProcessing Fundamentals, Material Jetting Machines, **Binder Jetting;** Materials, ProcessVariations, BJ Machines, **Sheet lamination Processes;** Materials, Ultrasonic AdditiveManufacturing, **Directed Energy Deposition Processes;** General DED Process Description,Material Delivery, DED systems, Process Parameters, Processing-Structure-PropertiesRelationships, **Direct Write Technologies;** Ink-Based DW, laser Transfer DW, Thermal SprayDW, Beam Deposition DW, Liquid Phase Direct Deposition, Hybrid Technologies.

UNIT-IV:

Design & Software Issues:

Additive Manufacturing Design and Strategies; Potentials and Resulting Perspectives, AMbased New Strategies, Material Design and Quality Aspects for Additive Manufacturing;Material for AM, Engineering Design Rules for AM.

Software Issue for Additive Manufacturing; Introduction, Preparation of CAD Models: TheSTL file, Problem with STL file, STL file Manipulation, Beyond the STL file, AdditionalSoftware to Assist AM.

UNIT-V:

Material Design & Quality Aspects:

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes,Intellectual Property, Product Development, Commercialization, Trends and Future Directions inAdditive Manufacturing, Business Opportunities

Applications:

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

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 Manufacturingby 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 SabrieSoloman.
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.

DEPARTMENTAL ELECTIVE-4

OPERATIONS RESEARCH

L-T-P
3-1-0

UNIT-I:
Introduction:
Basic of Operation Research, Origin & development of OperationResearch,Applications.
Linear Programming:
Introduction & Scope, Problem formulation, Graphical Method, Simplexmethods, primal and dual problem sensitivity analysis.

UNIT-II:
Transportation Problem:
Methods of obtaining initial and optimum solution, degeneracy intransportation problems, unbalanced Transportation Problem.
Assignment Problem:
Methods of obtaining optimum solution, Maximization problem,travelling salesman problem.

UNIT-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 LinearProgramming.
Sequencing:
Basic assumptions, n Jobs through 2-3 machines, 2 Jobs on m machines.

UNIT-IV:
Stochastic inventory models: Single & multi period models with continuous & discretedemands, Service level & reorder policy.
Simulation: Use, advantages & limitations, Monte-Carlo simulation, Application to queuing,inventory & other problems.

UNIT-V:
Queuing models: Characteristics of Queuing Model, M/M/1 and M/M/S system, costconsideration.
Project management: Basic Concept of network Scheduling, Rules for drawing networkdiagram, Applications of CPM and PERT techniques in Project planning and control; crashing ofoperations; resource allocation.

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, Prentice Hall.
3. Introduction to Operation Research, by- Gillett, McGraw Hill.
4. Operations Research - An Introduction, by- Hamdy A. Taha, Pearson India.
5. Operation Research, by- Wayne L. Winston, Thomsan Learning.
6. Problems in Operations Research by- Prem Kumar Gupta & D.S. Hira, S. Chand.
7. Operation Research Application and Algorithms, by- Wayne L Winston, Duxbury Press.
8. Operations Research, by Jha, McGraw Hill.
9. Operation Research, by Yadav & Malik Oxford University Press.

MODELLING AND SIMULATION

L-T-P
3-1-0

UNIT-I:
Bioinformatics objectives and overviews, Interdisciplinary nature ofBioinformatics, Data integration, Data analysis, MajorBioinformatics databases and tools. Metadata: Summary & referencesystems, finding new type of data online.Molecular Biology and Bioinformatics: Systems approach inbiology, Central dogma of molecular biology, problems inmolecular approach and the bioinformatics approach, overview of the bioinformatics applications.

UNIT-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 Quaternarystructure, Protein folding and function, Nucleic Acid-Proteininteraction.

UNIT-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 andUsing Biological Databases, Overview of Java, CORBA, XML, Webdeployment concepts.

UNIT-IV:
Genome, Genomic sequencing, expressed sequence tags, gene expression, transcription factor binding sites and single nucleotidepolymorphism. Computational representationsof molecular biological data storage techniques: databases (flat,relational and object oriented), and controlled vocabularies, general data retrieval techniques: indices, Booleansearch, fuzzy search and neighbouring, application to biological datawarehouses.

UNIT-V:
Macromolecular structures, chemical compounds, generic variability and its connection to clinical data. Representation of patterns andrelationships: sequence alignment algorithms, regular expressions, hierarchies and graphical models, Phylogenetics. BLAST.

Books and References:
1. D E Krane & M L Raymer," Fundamental concepts of Bioinformatics", Perason Education.
2. Rastogi, Mendiratta, Rastogi, "Bioinformatics Methods & applications, Genomics, Proteomics & Drug Discovery" PHI, New Delhi.
3. Shubha Gopal et.al. "Bioinformatics: with fundamentals of genomics and proteomics", Mc Graw Hill.
4. O'Reilly, "Developing Bio informatics computer skills", CBS.
5. Simulation Model Design& execution by Fishwich, 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.

COMPUTATIONAL FLUID DYNAMICS

L-T-P
3-1-0

UNIT- I:

Governing Equations and Boundary Conditions:

Basics of computational fluid dynamics. Governing equations of fluid dynamics. Continuity, Momentum and Energy equations. Chemical species transport. Physical boundary conditions,Time-averaged equations for Turbulent Flow. Turbulent–Kinetic Energy Equations Mathematicalbehaviour of PDEs onCFD. Elliptic, Parabolic and Hyperbolic equations.

UNIT -II:

Finite Difference Method:

Derivation of finite difference equations. Simple Methods. General Methods for first and secondorder accuracy, solution methods for finite difference equations. Elliptic equations. Iterativesolution Methods. Parabolic equations. Explicit and Implicit schemes. Example problems onelliptic and parabolic equations.

UNIT- III:

Finite Volume Method (FVM) for Diffusion:

Finite volume formulation for steady state One, Two- and Three-dimensional diffusion problems.One dimensional unsteady heat conduction through Explicit, Crank. Nicolson and fullyimplicit schemes.

UNIT -IV:

Finite Volume Method for Convection Diffusion:

Steady one-dimensional convection and diffusion. Central, upwind differencing schemespropertiesofdiscretization schemes. Conservativeness, Boundedness, Transportive, Hybrid,Power-law, QUICKSchemes.

UNIT- V:

Calculation Flow Field by FVM:

Representation of the pressure gradient term and continuity equation. Staggered grid. Momentumequations. Pressure and Velocity corrections; Pressure Correction equation, SIMPLE algorithmand itsvariants. Turbulence models, mixing length model, Two equation (k-Є) models. High andlow Reynoldsnumber models.

Books and References:

1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, by Versteeg, Pearson,
India.
2. Numerical Heat Transfer and Fluid Flow, by Patankar, Tayers&Francis.
3. Computational Heat Transfer, by Jaluriaans Torrance, CRC Press.
4. Computational Fluid Dynamics, by Anderson, Mc Graw Hill.
5. Computational Fluid Dynamics, by Chung, Cambridge University Press.
6. Computer Simulation of flow and heat transfer, by Ghoshdastidar McGraw Hill.
7. Introduction to Computational Fluid Dynamics, by Prodip Niyogi. Pearson India.
8. Computational Fluid Flow and Heat Transfer, by Muralidhar and Sundararajan, Narosa Publishing House.
9. Computational Fluid Dynamics: Principles and Applications, by Blazek, Elsevier Science & Technology.

AUTOMATION AND ROBOTICS

L-T-P
3-1-0

UNIT- I:

Automation:

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

UNIT- 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, multimodel and mixed modelproduction lines. Programmable Manufacturing Automation CNC machine tools, Machiningcentres, Programmable robots, Robot time estimation in manufacturing operations.

UNIT- III:

Robotics:

Definition, Classification of Robots - Geometric classification and Control classification, Lawsof Robotics, Robot Components, Coordinate Systems, Power Source.Robot anatomy, configuration of robots, joint notation schemes, work volume, manipulatorkinematics, position representation, forward and reverse transformations, homogeneoustransformations in robot kinematics, D-H notations, kinematics equations, introduction to robotarm dynamics.

UNIT -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 toRotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Leadscrews, Ball Bearings.

Robot end Effectors:

Classification of End effectors – active and passive grippers, Tools as end effectors, Drivesystem for grippers. Mechanical, vacuum and magnetic grippers. Gripper force analysis andgripper design.

UNIT- V:

Robot Simulation:

Methods of robot programming, Simulation concept, Off-line programming, advantages of offlineprogramming.

Robot Applications:

Robot applications in manufacturing-Material transfer and machine loading/unloading,Processing operations like Welding & painting, Assembly operations, Inspection automation,Limitation of usage of robots in processing operation.Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference.

Books and References:

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

SEMESTER-VIII

DEPARTMENTAL ELECTIVE-5

NON-DESTRUCTIVE TESTING

L-T-P
3-1-0

Unit-I:
Introduction:
Scope and advantages of NDT, Comparison of NDT with Destructive Testing, some commonNDT methods used since ages, Terminology, Flaws and Defects, Visual inspection, Equipmentused for visual inspection. Ringing test, chalk test (oil whitening test). Uses of visual inspectiontests in detecting surface defects and their interpretation, advantages & limitations of visualinspection.

Unit-II:
Tests:
Die penetrate test (liquid penetrate inspection), Principle, scope. Equipment & techniques, Testsstations, Advantages, types of penetrants and developers, Zyglo test, Illustrative examples andinterpretation of defects.
Magnetic particle Inspection – scope and working principle, Ferro Magnetic and Nonferromagneticmaterials, 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.

Unit-III:
Radiographic methods:
Introduction to electromagnetic waves and radioactivity, various decays, Attenuation ofelectromagnetic radiations, Photo electric effect, Rayleigh's scattering (coherent scattering),Compton's scattering (Incoherent scattering), Pair production, Beam geometry and Scatteringfactor.
X-ray radiography: principle, equipment & methodology, applications, types of radiations andlimitations. γ-ray radiography – principle, equipment., source of radioactive materials &technique, advantages of γ-ray radiography over X-ray radiography Precautions against radiationhazards. Case Study - casting and forging.

Unit-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.

Unit-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.

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, WoodheadPublishing.
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.

ADVANCED WELDING

L-T-P
3-1-0

UNIT-I:

Introduction: Welding as compared with other fabrication processes, Importance andapplication of welding, classification of welding processes, Health & safety measures inwelding.

Welding Power Sources: Physics of welding Arc**,** Basic characteristics of power sources forvarious arc welding processes, Transformer, rectifier and generators.

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

Metal Transfer: Mechanism and types of metal transfer in various arc welding processes.

UNIT-II:

Welding Processes:

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

UNIT-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 theirmeasurement; weld distortion and its prevention.

UNIT-IV:

Repair & Maintenance Welding:

Hardfacing, Cladding, Surfacing, Metallizing processes andReclamation welding.

Weldability: Effects of alloying elements on weld ability, welding of plain carbon steel, CastIron and aluminium. Micro & Macro structures in welding.

UNIT-V:

Weld Design:

Types of welds & joints, Joint Design, Welding Symbols, weld defects,Inspection/testing of welds, Introduction to Welding Procedure Specification & ProcedureQualification Record.

Books and References:

1. Welding and Welding Technology, by- Richard L. Little, McGraw Hill Education.
2. Welding Principals and Practices, by- Edwars R. Bohnart, McGraw Hill Education.
3. Welding Engineering and Technology, by- R. S. Parmar, Khanna Publishsers.
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. Modern Welding Technology by Howard B Cary and Scott Helzer.
8. Welding Handbooks (Vol. I & II).

THERMAL TURBOMACHINES

L-T-P
3-1-0

UNIT-I:
Brief history of turbo machinery, introduction to blowers, pumps, compressors, steam &gasturbines, turbojet, Review of laws of thermodynamics & SFEE in reference to turbomachinery,Energy transfer in turbo machines, Euler's equation, Definition of variousefficiencies, preheatfactor, Reheat factor, Blade classification, Blade terminology,Cascade testing, Velocity diagramsfor axial and radial turbomachinery and pumps.

UNIT-II:
Centrifugal compressors:
Principle of operation, work done and pressure rise, Velocitydiagramfor centrifugal compressor, Slip factor, Stage pressure rise, Loading coefficient,Diffuser, degreeof reaction, Effect of impeller blade profile, Pre-whirl and inlet guide vanes, CentrifugalCompressor characteristic curves.
Axial flow compressor:
Principle of operation and working, Energy transfer, Velocitydiagramfor axial compressor, Factors affecting stage pressure ratio, Blockage incompressor annulus,Degree of reaction, 3-D flow, Design process, blade design,calculation of stage performance,Axial compressor performance characteristic curves.

UNIT-III:
Axial flow turbines:
Elementary theory of axial flow turbine, Energy transfer, Velocitydiagram,Types of blades, Vortex theory, Choice of blade profile, pitch and chord,Estimation of stageperformance, Characteristic curves.

UNIT-IV:
Steam turbines: Constructional details, working of steam turbine.
Pumps: Classification of Pumps, Main components, indicator diagram and modificationdue topiston acceleration, Performance characteristics, Cavitation and its control,Miscellaneous types of pumps.
Radial flow turbines: Elementary theory of radial flow turbines, Enthalpy- Entropydiagram,State losses, Estimation of stage performance, Performance characteristics.

UNIT-V:
Gas Turbine Starting & Control Systems: Starting ignition system, Combustionsystem types,Safety limits & control.
Turbine Blade coding: Different cooling techniques, Types of coolants, Comparativeevaluationof different cooling techniques.
Mechanical Design consideration: Overall design choices, Material selection, Designwithtraditional materials.

Books and References:
1. Gas turbine theory: Cohen & Rogers, Addison Weslay Longman Ltd.
2. Turbine, Compressors and Fans, S.M. Yahya, Tata Mc Graw Hill.
3. Gas Turbine- Ganeshan, Tata Mc Graw Hill.
4. Thermal Turbomachines, by Singh, Wiley.
5. Fundamentals of Turbomachinery, by Venkanna, PHI, India.
6. Turbo Machine by S L Dixon.
7. Turbines, Compressors & Fans by Yahya.
8. Fundamentals of Turbomachinery by Venkanna, PHI, India.

ENERGY CONSERVATION ANDMANAGEMENT

L-T-P
3-0-0

UNIT -I:
Introduction to energy & power scenario of world, National Energy consumption data,environmental aspects associated with energy utilization; Energy Auditing- need, types,methodology and barriers, role of energy managers, instruments of energy auditing.

UNIT -II:
Components of EB billing, HT and LT supply, transformers, cable sizing; Concept ofcapacitors, power factor improvement, harmonics; Electric motors- motor efficiencycomputation, energy efficient motors; Illumination- Lux, Lumens, types of lighting, efficacy,LED lighting and scope of energy conservation in lighting.

UNIT -III:
Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation andenergy conservation measures; Steam distribution and usage, steam traps, condensaterecovery, flash steam utilization; Insulation & Refractories.

UNIT -IV:
Energy conservation in major utilities; pumps, fans, blowers, compressed air systems,Refrigeration& Air Conditioning systems, Cooling Towers, DG sets.

UNIT-V:
Energy Economics- discount period, payback period, internal rate of return, net present value;Life Cycle costing- ESCO concept.

Books and References:
1. Witte L.C., Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization,Hemisphere Publ., Washington, 1988.
2. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press,Oxford, 1981.
3. Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.
4. Energy Management and Conservation by K V Sharma and P Venkataseshaiah
5.Energy Management and Conservation Handbook (Mechanical and Aerospace Engineering Series)by Frank Kreith and D Yogi Goswami
6. Energy Conversion and Management by Giovanni Petrecca
7. World Energy Resources: International Geohydroscience and Energy Research Institute by Charles Brown
8. Energy Manager Training Manual, Bureau of Energy Efficiency (BEE) under Ministry ofPower, GOI, 2004 (available at www.energymanager training.com).

DEPARTMENTAL ELECTIVE-6

TOTAL QUALITY MANAGEMENT (TQM)

L-T-P
3-0-0

UNIT -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 ofsources, procurement procedure.

Manufacturing Quality:

Methods and Techniques for manufacture, Inspection and control of product, Quality in sales andservices, Guarantee, analysis of claims.

UNIT -II:

Quality Management:

Organization structure and design, Quality function, decentralization, Designing and fittingorganization for different types products and company, Economics of quality value andcontribution, Quality cost, optimizing quality cost, seduction programme.

TQM Principles:

Leadership, strategic quality planning; Quality councils- employeeinvolvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognitionand reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S,Kaizen; Supplier partnership, Partnering, Supplier rating & selection.

UNIT -III:

Tools and Techniques:

Seven QC tools (Histogram, Check sheet, Ishikawa diagram, Pareto, Scatter diagram, Controlchart, 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.

UNIT -IV:

Defects Diagnosis and Prevention:

Defect study, identification and analysis of defects, corrective measure, factors affectingreliability, MTTF, calculation of reliability, Building reliability in the product, evaluation ofreliability, interpretation of test results, reliability control, maintainability, zero defects, qualitycircle.

UNIT -V:

IS0and 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.

Books and References:

1. Total Quality Management, by Dale H. Besterfield, Pearson India.
2. Beyond Total Quality Management, Greg Bounds, McGraw Hill.
3. Besterfield D.H. et al., Total qualityManagement, 3rd ed., Pearson Education Asia, 2006.

4. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., firstIndian 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, McGraw Hill.

GAS DYNAMICS AND JETPROPULSION

L-T-P
3-1-0

UNIT -I:
Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass,momentum and energy equations of one-dimensional flow.

UNIT-II:
Isentropic flow through variablearea ducts, nozzle s and diffusers, subsonic and supersonic flow I variable area ducts, chokedflow, Area-Mach number relations for isentropic flow.

UNIT -III:
Non-isentropic flow in constant area ducts, Rayleigh and Fano flows, Normal shockrelations, oblique shock relations, isentropic and shock tables.

UNIT -IV:
Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operatingprinciple and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

UNIT -V:
Types of rocket engines, propellants & feeding systems, ignition and combustion, theory ofrocket propulsion, performance study, staging, terminal and characteristic velocity, spaceflights.

Books and References:
1. Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, “Understanding Aerospace Chemical Propulsion”, Interline Publishing,2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley,1992.
4. Zucrow N. J., Aircraft and Missile Propulsion, Vol.I& II, John Wiley, 1975.
5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.

DESIGN OF TRANSMISSION SYSTEMS

L-T-P

3-0-0

UNIT -I:

Flexible transmission elements:
Design of flat belts & pulleys, selection of V-belts andpulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets.

UNIT -II:
Gear transmission:
Speed ratios and number of teeth, force analysis, tooth stresses, dynamiceffects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear andparallel axis helical gears based on strength and wear considerations, pressure angle in thenormal and transverse plane; equivalent number of teeth and forces for helical gears.

UNIT -III:
Straight bevel gear:
Tooth terminology, tooth forces and stresses, equivalent number of teeth.Estimating the dimensions of a pair of straight bevel gears; Worm gear, merits & demerits,terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size ofworm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helicalgears.

UNIT -IV:
Gear box:
Geometric progression, standard step ratio; Ray diagram, kinematics layout;Design of sliding mesh gear box- Design of multi-seed gear box for machine toolapplications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluidcouplings, Torque converters for automotive applications.

UNIT -V:
Cam design, types:
Pressure angle and undercutting base circle determination, forces andsurface stresses; Design of plate clutches, axial clutches, cone clutches, internal expandingrim clutches; Electromagnetic clutches; Band and Block brakes, external shoe brakes, internalexpanding shoe brake.

Books and References:
1. Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8th ed., Tata McGraw Hill, 2010.
2. Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
3. Design of transmission systems by Eamanamurthy and S Machandran.
4. Electrical Power Transmission System Engineering: Analysis and Design" by TuranGonen.
5. Experimental Stress Analysis for Materials and Structures (Springer Series in Solid and Structural Mechanics)" by Alessandro Freddi and Giorgio Olmi.
6. Radio Frequency Transmission Systems: Design and Operation" by Jerry Whitaker.
7. Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill, 2001.

THEORY OF ELASTICITY

L-T-P

3-0-0

UNIT I:
Basic Equations of Elasticity:
Definition of Stress and Strain: Stress – Strain Relationships – Equations of Equilibrium, Compatibility Equations, Boundary Conditions, Saint Venant'sprinciple – Principal Stresses, Stress Ellipsoid – Stress Invariants.

UNIT II:
Plane Stress and Plane Strain Problems:
Airy's Stress Function, Bi-Harmonic Equations, Polynomial Solutions, Simple Two-Dimensional Problems in Cartesian Coordinates Like Bending of Cantilever and Simply Supported Beams.

UNIT III:
Polar Coordinates:
Equations of Equilibrium, Strain – Displacement Relations, Stress – Strain Relations, Airy's Stress Function, Axis – Symmetric Problems, Introduction toDunder's Table, Curved Beam Analysis, Lame's, Kirsch, Michell's And Boussinesque Problems – Rotating Discs.

UNIT IV:
Torsion:
Navier's Theory, St. Venant's Theory, Prandtl's Theory on Torsion, Semi- Inverse Method and Applications to Shafts of Circular, Elliptical, Equilateral Triangular and Rectangular Sections. Membrane Analogy.

UNIT V:
Introduction to Theory of Plates and Shells:
Classical Plate Theory – Assumptions – Governing Equations – Boundary conditions – Navier's Method of Solution for Simply Supported Rectangular Plates Levy's Method of Solution forRectangular Plates Under Different Boundary Conditions.

Books and References:
1. Wang, C. T., "Applied Elasticity", McGraw – Hill Co., New York, 1993.

2. Sokolnikoff, I. S., "Mathematical Theory of Elasticity", McGraw – Hill, New York, 1978.

3. Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991.

4. Barber, J. R., "Elasticity", Kluwer Academic Publishers, 2004.

5. Theory of elasticity by S.Timoshenko.

B.TECH.
VII SEMESTER 2020-21

REVISED OPEN ELECTIVE-I

1.	ROE070	HUMAN VALUES IN SANKHAY YOGA AND VEDANTA DARSAN
2.	ROE071	MODELLING AND SIMULATION OF DYNAMIC SYSTEMS
3.	ROE072	INTRODUCTION TO SMART GRID
4.	ROE073	CLOUD COMPUTING
5.	ROE074	UNDERSTANDING THE HUMAN BEING COMPREHENSIVELY - HUMAN ASPIRATIONS AND ITS FULFILLMENT
6.	ROE075	AUTOMATION AND ROBOTICS
7.	ROE076	COMPUTERIZED PROCESS CONTROL
8.	ROE077	MODELING OF FIELD-EFFECT NANO DEVICES
9.	ROE078	QUALITY MANAGEMENT
10.	ROE079	GIS & REMOTE SENSING
11.	ROE080	HUMAN VALUES IN BUDDHA AND JAIN DARSHAN

ROE 070	**Human Values in Sankhya, Yoga and Vedanta Darshan**	**L** 3	**T** 0	**P** 0	**C** 3
Version No.:	2.0 (updated as on June 12 '19)				
Prerequisite:	KVE 301/401- Universal Human Values and Professional Ethics				

Objectives:

1. To help students understand the basic principles of Sankhya, Yoga and Vedanta Darshan
2. To help students understand the existential realities including the human existence through Sankhya, Yoga and Vedanta 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

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

1. Understand the basic concepts of Sankhya, Yoga and Vedanta Darshan.
2. Understand the human being, the needs and activities of human being through Sankhya, Yoga and Vedanta Darshan.
3. Understand the whole existence
4. Understand the role of human being in the entire existence, thus getting clarity about values at all levels of living and human conduct
5. Understand the foundation of human society and human tradition.

Catalogue Description: Sankhya, Yoga and Vedanta Darshan form a part of the philosophy of Indian tradition. This course outlines the basic concepts and principles of these three philosophies and provides scope for further reading of the philosophies, so as to gain clarity about the human being, the existence and human participation i.e. human values expressing itself in human conduct.
It is to be kept in mind that Darshan means realisation 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.

Module I :Introduction to Sankhya, Yoga and Vedanta Darshan and their Basics

Need to study Sankhya, Yoga and Vedanta Darshan; the origin of the three philosophies, their basic principles and scope for further reading.

Module II: Sankhya Darshan

Sankhya Darshan- the *nature* of *Purush* and *Prakriti*, 8 types of *prakriti (pradhan, mahattatva ahankar and* five *tanmatras*- sound, touch, form, taste and smell) and their 16 evolutes (*vicar), pramana (pratyaksha, anumana and agama),* bondage and salvation (liberation), the principle of *satkaryavad*, sense organs, work organs, *trigunatmak prakriti*

Module III: YogaDarshan

Yoga Darshan- the steps of *Ashtanga yoga (yama, niyama,aasana, pranayama, pratyahara, dharana, dhyan* and *samadhi*) and the challenges in following them, afflictions (*klesha)- avidya asmita, raga, dvesha, abhinivesh,* different types of *vritti (pramana, viparyaya, vikalp, nidra, smriti),* the process of *nirodha* of *vritti*; *maitri, karuna, mudita, upeksha;* description of *yama, niyama aasana* and *pranayaama; kriyayoga –tapa, swadhyaya* and *ishwar-pranidhana,* different steps of *samadhi,* different types of *sanyama, vivekakhyati, pragya.*

Module IV :Vedanta Darshan

Vedanta Darshan- *Nature* of *Brahma* and *Prakriti*, Methods of *Upasana*; a*dhyasa* and s*anskar* n*ature* of Atma, description of existence, principle of *karma-phala*, description of *pancha kosha* different *nature* of *paramatma/brahma, Ishwar, Four qualifications (Sadhan-chatushtay)*.

Module V : Purpose and Program for a Human Being based on the Three Darshan

The purpose and program of a human being living on the basis of the three darshanas, clarity and practice of human values and human conduct, the natural outcome of such a program on society nature and tradition. possibility of finding solutions to present day problems in the light of it.

Text Books:

1. Chattejee, S.G. and Datta, D.M., "*An Introduction to Indian Philosophy*", University of Calcutta Press, 1960.

References:

1. Goendaka, J., "*Shreemad Bhagwat Geeta*", Geeta Press, Gorakhpur, 73rd reprint, 2015.
2. Krishna, I., "*The Sankhya Karika*", Bharatiya Vidya Prakashan, 4th edition, 2010.
3. Madhavacharya, "*Sarva-darshan Samgraha*", Chaukhambha Vidya Bhavan, Varanasi, 1984.
4. Maharaj, O. "*Patanjal Yog Pradeep*", Geeta press, Gorakhpur, 30th reprint, 2009.
5. Muller, F.M. "*The Six Systems of Indian Philosophy"*, Longmans Green and Co. Publication, London, 1928.
6. Radhakrishnan, S., "*Indian Philosophy* (*Volume* 1 and 2)", Oxford University Press, 2nd edition, 1996.
7. Shankaracharya, "*Vivek Choodamani",* Geeta Press, Gorakhpur, 48th Reprint, 2018.
8. Sivananda, S., "*Raj Yoga*", The Divine Life Society, Rishikesh, 7th edition, 2016.
9. Vachaspati, M., "*Sankhya Tatva Kaumudi*", Motilal Banarasi Das Publication, Varanasi 1921.

Mode of Evaluation: Assignment/ Seminar/Continuous Assessment Test/Semester End Exam

ROE-071 MODELLING AND SIMULATION OF DYNAMIC SYSTEMS

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Define, describe and apply basic concepts related to modeling and simulation.
2. Use conservation laws and constitutive relationships and other physical relations to model mechanical, electrical and flow systems, and combinations of these.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Define, describe and apply basic concepts related to modeling and simulation.

CO2: Construct bond graphs for the type of systems mentioned above, simplify and analyze the bond graph according to causality conflicts.

CO3: Use conservation laws and constitutive relationships and other physical relations to model mechanical, electrical and flow systems.

CO4: Find dynamic response and transfer function using various tools for system modeling.

CO5: Model and simulate mechanical and electrical systems using the computer tools Simulink.

ROE-071 MODELLING AND SIMULATION OF DYNAMIC SYSTEMS		
Unit	**Topic**	**Lectures**
1	**Introduction to modeling and simulation:** Introduction to modeling, Examples of models, modeling of dynamic system, Introduction to simulation, MATLAB as a simulation tool, Bond graph modeling, causality, generation of system equations.	**8**
2	**Bond graph modeling of dynamic system:** Methods of drawing bond graph model- Mechanical systems & Electrical systems, some basic system models- Mechanical systems, Thermal systems, hydraulic systems, pneumatic systems and electrical systems.	**8**
3	**System models of combined systems:** Linearity and non linearity in systems combined rotary and translatory system, electro mechanical system, hydro-mechanical system.	**8**
4	**Dynamic Response and System Transfer Function:** Dynamic response of 1^{st} order system and 2^{nd} order system, performance measures for 2^{nd} order system, system transfer function, transfer function of 1^{st} and 2^{nd} order system Block diagram algebra, signal flow diagram, state variable formulation, frequency response and bode plots.	**8**
5	**Simulation and simulation applications:** Simulation using SIMULINK, examples of simulation problems- simple and the compound pendulum, planner mechanisms, validation and verification of the simulation model, parameter estimation methods, system identifications, introduction to optimization.	**8**

Text Books and References:

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2nd Edition. Academic press 2000.
2. Robert L. Woods, Kent L. Lawrence, “Modeling and simulation of dynamic systems”, Person, 1997.
3. Brown, Forbes T. “Engineering System Dynamics”, New York, NY: CRC, 2001. ISBN: 9780824706166.
4. Pratab.R " Getting started with MATLAB" Oxford university Press 2009.

ROE-072 INTRODUCTION TO SMART GRID

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Present the fundamental concepts associated with Smart Grids.
2. Review renewable energy generation, grid integration energy storage technologies and future developments
3. Introduce advanced management and control concepts of Smart Grids.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Identify the key elements of Smart Grids and visualize the roadmap towards next-Gen electricity networks.

CO2: Evaluate technology options pertaining to renewable energy generation, energy storage, data handling and communications for Smart Grids.

CO3: Justify technological and economical choices in the context of existing commercial Smart Grids projects.

CO4: Determine the relevance of Smart Grids projects, develop ways to evaluate their impacts and implications.

CO5: Analyse the new roles of utilities and consumers in Smart Grids.

ROE-072 INTRODUCTION TO SMART GRID		
Unit	**Topic**	**Lectures**
1	**Introduction: Introduction to Smart Grid:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid.	8
2	**Smart Grid Technologies:** Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation.	8
3	**Smart Grid Technologies:** Smart Substations, Substation Automation, Feeder Automation, Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase Measurement Unit (PMU), PMUs application to monitoring & control of power system.	8
4	**Microgrids and Distributed Energy Resources:** Concept of microgrid, need & application of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid, Plastic & Organic solar cells, thin flim solar cells, Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources.	8
5	**Power Quality Management in Smart Grid**: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring.	8

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai, "Integration of Green and Renewable Energy in Electric Power Systems", Wiley.
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
3. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.
4. Jean Claude Sabonnadiere, NouredineHadjsaid, "Smart Grids", Wiley Blackwell 19.
5. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press.

Reference Books:

1. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability", Artech House Publishers July 2011.
2. James Northcote, Green, Robert G. Wilson "Control and Automation of Electric Power Distribution Systems (Power Engineering)", CRC Press.
3. MladenKezunovic, Mark G. Adamiak, Alexander P. Apostolov, Jeffrey George Gilbert "Substation Automation (Power Electronice and Power Systems)", Springer.
4. R.C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, "Electrical Power System Quality", 2nd Edition, McGraw Hill Publication.
5. Phadke, A.G., Thorp, J.S., "Synchronized Phasor Measurements and Their Applications", Springer.
6. James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley.

ROE-073 CLOUD COMPUTING

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Provide students with the fundamentals and essentials of Cloud Computing..
2. Provide students a sound foundation of the Cloud Computing so that they are able to start using and adopting Cloud Computing services and tools in their real life scenarios.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Articulate the main concepts, key technologies, strengths and limitations of cloud computing.

CO2: Learn the key and enabling technologies that help in the development of cloud.

CO3: Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models..

CO4: Explain the core issues of cloud computing such as resource management and security.

CO5: To appreciate the emergence of cloud as the next generation computing paradigm.

ROE-073 CLOUD COMPUTING		
Unit	**Topic**	**Lectures**
1	**Introduction :** Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning.	**8**
2	**Cloud Enabling Technologies:** Service Oriented Architecture – REST and Systems of Systems – Web Services Publish-Subscribe Model – Basics of Virtualization – Types of Virtualization Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms–Virtualization of CPU–Memory–I/O Devices–Virtualization Support and Disaster Recovery.	**8**
3	**Cloud Architecture, Services And Storage:** Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds – laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage- as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.	**8**
4	**Resource Management And Security In Cloud:** Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a- Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards.	**8**
5	**Cloud Technologies And Advancements:** Hadoop – Map Reduce – Virtual Box — Google App Engine – Programming Environment for Google App Engine — Open Stack – Federation in the Cloud – Four Levels of Federation – Federated Services and Applications – Future of Federation.	**8**

Text and Reference Books:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, John W., and James F. Ransome, —Cloud Computing: Implementation, Management and Security, CRC Press, 2017.
3. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, —Mastering Cloud Computing, Tata Mcgraw Hill, 2013.
4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009.
5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009.

ROE- 074 Understanding the Human Being Comprehensively–Human Aspirations and its Fulfillment

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. To help the students having the clarity about human aspirations, goal, activities and purpose of life.
2. To facilitate the competence to understand the harmony in nature/existence and participation of human being in the nature/existence.
3. To help the students to develop the understanding of human tradition and its various components.

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 pre- conditionings and present beliefs.

ROE- 074 Understanding the Human Being Comprehensively–Human Aspirations and its Fulfillment		
Unit	**Topic**	**Lectures**
1	**Introduction:** The basic human aspirations and their fulfillment through Right understanding and Resolution; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.	8
2	**Understanding Human being and its expansion:** The domain of right understanding starts from understanding the human being (the knower, the experiencer and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	8
3	**Activities of the Self:** Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Reasons for harmony/contradiction in the self.	8

4	**Understanding Co-existence with other orders:** The need and the process of inner evolution (through self-exploration, self- awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence)	8
5	**Expansion of harmony from self to entire existence:** Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behaviour and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence..	8

Reference Books:

1. A Foundation Course in Human Values and Profession Ethics (Text Book and Teachers' Manual), R. R. Gaur, R. Sangal, G. P. Bagaria (2010), Excel Books, New Delhi [ISBN 978-8-174-46781-2]
2. Avartansheel Arthshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India
3. Economy of Permanence – (a quest for social order based on non-violence), J.C.Kumarappa (2010), Sarva-Seva-Sangh-Prakashan, Varansi, India
4. Energy and Equity, Ivan Illich (1974), The Trinity Press, Worcester & Harper Collins, USA
5. IshandiNauUpnishad, Shankaracharya, Geeta press, Gorakhpur,
6. Manav Vyavahar Darshan, A. Nagraj, Divya Path Sansthan, Amarkantak, India
7. Manaviya Sanvidhan, A. Nagraj, Divya Path Sansthan, Amarkantak, India
8. MahasatipatthanSutta , S N Goenka, Vipassana Research Institute, First Edition, 1996
9. Small Is Beautiful: A Study of Economics as if People Mattered, E. F. Schumacher, 1973, Blond & Briggs, UK
10. Slow is Beautiful, Cecile Andrews http://www.newsociety.com/Books/S/Slow- is-Beautiful)
11. Science & Humanism – towards a unified worldview, P. L. Dhar & R. R. Gaur (1990), Commonwealth Publishers, New Delhi
12. Sanchian Sri Guru Granth Sahib Ji ,Shiromani Gurdwara Parbhandhak Committee, 2001
13. SamanSuttam, JinendraVarni ,1974.
14. Vyavaharvadi Samajshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India
15. Vyavahatmak Janvad, A. Nagraj, Divya Path Sansthan, Amarkantak, India.

ROE-075 AUTOMATION AND ROBOTICS

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Acquire the knowledge on advanced algebraic tools for the description of motion.
2. Develop the ability to analyze and design the motion for articulated systems.
3. Develop an ability to use software tools for analysis and design of robotic systems

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Use matrix algebra and Lie algebra for computing the kinematics of robot.

CO2: Calculate the forward kinematics and inverse kinematics of serial and parallel robots.

CO3: Calculate the Jacobian for serial and parallel robot.

CO4: Do the path planning for a robotic system.

CO5: Be proficient in the use of Maple or Matlab for the simulation of robots.

ROE-075 AUTOMATION AND ROBOTICS		
Unit	**Topic**	**Lectures**
1	**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**
2	**Manufacturing Automation:** Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimode and mixed model production lines. Programmable Manufacturing Automation CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations.	**8**
3	**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, manipulator kinematics, position representation, forward and reverse transformations, homogeneous transformations in robot kinematics, D-H notations, kinematics equations, introduction to robot arm dynamics.	**8**
4	**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, Rack and Pinion drives, Lead screws, Ball Bearings. Robot end Effectors: Classification of End effectors – active and passive grippers, Tools as end effectors, Drive system for	**8**

	grippers. Mechanical, vacuum and magnetic grippers. Gripper force analysis and gripper design.	
5	**Robot Simulation:** Methods of robot programming, Simulation concept, Off-line programming, advantages of offline programming. Robot Applications: Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Limitation of usage of robots in processing operation. Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference.	**8**

Text Books and References:

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

ROE-076 COMPUTERIZED PROCESS CONTROL

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Understand Basics of Computer-Aided Process Control.
2. Analyse Industrial communication System.
3. Design Process Modelling for computerized Process control.
4. Design Advanced Strategies For Computerised Process control.
5. Analyse Computerized Process Control.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Understand the Role of computers in process control, Elements of a computer aided Process control System, Classification of a Computer.

CO2: Design Phase Locked Local Loop, Mixers. Time Division Multiplexed System – TDM/PAM system.

CO3: Realize Process model, Physical model, Control Model. Modelling Procedure.

CO4: Formulate of Cascade Control, Predictive control, Adaptive Control, Inferential control, Intelligent Control, Statistical control.

CO5: Design Electric Oven Temperature Control, Reheat Furnace Temperature control.

ROE-076 COMPUTERIZED PROCESS CONTROL		
Unit	**Topic**	**Lectures**
1	Basics of Computer-Aided Process Control: Role of computers in process control, Elements of a computer aided Process control System, Classification of a Computer –Aided Process Control System Computer Aided Process–control Architecture: Centralized Control Systems, Distributed control Systems, Hierarchical Computer control Systems. Economics of Computer-Aided Process control. Benefits of using Computers in a Process control. Process related Interfaces: Analog Interfaces, Digital Interfaces, Pulse Interfaces, Standard Interfaces.	**8**
2	Industrial communication System: Communication Networking, Industrial communication Systems, Data Transfer Techniques, Computer Aided Process control software, Types of Computer control Process Software, Real Time Operating System	**8**
3	Process Modelling for computerized Process control: Process model, Physical model, Control Model, Process modelling. Modelling Procedure: Goals Definition, Information Preparation, Model Formulation, Solution Finding, Results Analysis, Model Validation	**8**
4	Advanced Strategies For Computerised Process control: Cascade Control, Predictive control, Adaptive Control, Inferential control, Intelligent Control, Statistical control.	**8**

5	Examples of Computerized Process Control: Electric Oven Temperature Control, Reheat Furnace Temperature control, Thickness and Flatness control System for metal Rolling, Computer-Aided control of Electric Power Generation Plant.	**8**

Text Books:

1. S. K. Singh, "Computer Aided Process control", PHI.

Reference Books:

1. C. L. Smith, "Digital computer Process Control", Ident Educational Publishers.
2. C. D. Johnson, "Process Control Instrumentation Technology", PHI.
3. Krishan Kant, "Computer Based Industrial Control"
4. Pradeep B. Deshpande & Raymond H. Ash, "Element of Computer Process Control with Advance Control Applications", Instrument Society of America, 1981.
5. C. M. Houpis & G. B. Lamond, "Digital Control System Theory", Tata McGraw Hill.

ROE-077 MODELING OF FIELD-EFFECT NANO DEVICES

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

3. Introduce novel MOSFET devices and understand the advantages of multi-gate devices.
4. Introduce the concepts of nanoscale MOS transistor and their performance characteristics.
5. Study the various nano-scaled MOS transistor circuits.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Study the MOS devices used below 10nm and beyond with an eye on the future.
CO2: Understand and study the physics behind the operation of multi-gate systems.
CO3: Design circuits using nano-scaled MOS transistors with the physical insight of their functional characteristics.
CO4: Understand and study the physics behind the Radiation effects in SOI MOSFETs.
CO5: Understand the impact of device performance on digital circuits.

ROE-077 MODELING OF FIELD-EFFECT NANO DEVICES		
Unit	**Topic**	**Lectures**
1	MOSFET scaling, short channel effects - channel engineering - source/drain engineering - high k dielectric - copper interconnects - strain engineering, SOI MOSFET, multigate transistors – single gate – double gate – triple gate – surround gate, quantum effects – volume inversion – mobility – threshold voltage – inter subband scattering, multigate technology – mobility – gate stack	**8**
2	MOS Electrostatics – 1D – 2D MOS Electrostatics, MOSFET Current-Voltage Characteristics – CMOS Technology – Ultimate limits, double gate MOS system – gate voltage effect - semiconductor thickness effect – asymmetry effect – oxide thickness effect – electron tunnel current – two dimensional confinement, scattering – mobility	**8**
3	Silicon nanowire MOSFETs – Evaluvation of I-V characteristics – The I-V characteristics for nondegenerate carrier statistics – The I-V characteristics for degenerate carrier statistics – Carbon nanotube – Band structure of carbon nanotube – Band structure of graphene – Physical structure of nanotube – Band structure of nanotube – Carbon nanotube FETs – Carbon nanotube MOSFETs – Schottky barrier carbon nanotube FETs – Electronic conduction in molecules – General model for ballistic nano transistors – MOSFETs with 0D, 1D, and 2D channels – Molecular transistors – Single electron charging – Single electron transistors.	**8**

4	Radiation effects in SOI MOSFETs, total ionizing dose effects – single-gate SOI – multi-gate devices, single event effect, scaling effects	**8**
5	Digital circuits – impact of device performance on digital circuits – leakage performance trade off – multi VT devices and circuits – SRAM design, analog circuit design – transconductance - intrinsic gain – flicker noise – self heating –band gap voltage reference – operational amplifier – comparator designs, mixed signal – successive approximation DAC, RF circuits.	**8**

Text and Reference Books:

1. J P Colinge, "FINFETs and other multi-gate transistors", Springer – Series on integrated circuits and systems, 2008
2. Mark Lundstrom, Jing Guo, "Nanoscale Transistors: Device Physics, Modeling and Simulation", Springer, 2006
3. M S Lundstorm, "Fundamentals of Carrier Transport", 2nd Ed., Cambridge University Press, Cambridge UK, 2000.

ROE-078 QUALITY MANAGEMENT

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Introduce the importance of quality in improving competitiveness.
2. Understand the Implication of Quality on Business.
3. Implement Quality Implementation Programs.
4. Have exposure to challenges in Quality Improvement Programs.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Realize the importance of significance of quality.
CO2: Manage quality improvement teams.
CO3: Identify requirements of quality improvement programs.
CO4: Identify improvement areas based on cost of poor quality.
CO5: Organize for quality and development of quality culture through small group activities.

ROE-078 QUALITY MANAGEMENT		
Unit	**Topic**	**Lectures**
1	Quality Concepts: Evolution of Quality Control, concept change, TQM Modern concept, Quality concept in design, Review of design, Evolution of proto type. 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**
2	Quality Management: Organization structure and design, quality function, decentralization, designing and fitting, organization for different type products and company, economics of quality value and contribution, quality cost, optimizing quality cost, seduction program. Human Factor in quality Attitude of top management, cooperation of groups, operators attitude, responsibility, causes of apparatus error and corrective methods.	**8**
3	Control Charts, Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts. Attributes of Control Chart, Defects, construction and analysis of charts, improvement by control chart, variable sample size, construction and analysis of C charts.	**8**
4	Defects diagnosis and prevention defect study, identification and analysis of defects, correcting measure, factors affecting reliability, MTTF, calculation of reliability, building reliability in the product, evaluation of reliability, interpretation of test	**8**

	results, reliability control, maintainability, zero defects, quality circle.	
5	ISO-9000 and its concept of Quality Management, ISO 9000 series, Taguchi method, JIT in some details.	**8**

Text and Reference Books:

1. Lt. Gen. H. Lal, "Total Quality Management", Eastern Limited, 1990.
2. Greg Bounds, "Beyond Total Quality Management", McGraw Hill, 1994.

Menon, H.G, "TQM in New Product manufacturing", McGraw Hill 1992

ROE-079 GIS & REMOTE SENSING

COURSE OBJECTIVE: *Students undergoing this course are expected to-*

1. Understand about the principles of GIS, Remote Sensing, Spatial Systems, and its applications to Engineering Problems.

COURSE OUTCOME: *After completion of the course student will be able to-*

CO1: Understand about the principles of Remote Sensing and its advantages and limitations.
CO2: Retrieve the information content of remotely sensed data.
CO3: Apply problem specific remote sensing data for engineering applications.
CO4: Analyze spatial and attribute data for solving spatial problems.
CO5: Create GIS and cartographic outputs for presentation

ROE-079 GIS & REMOTE SENSING		
Unit	**Topic**	**Lectures**
1	Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; major atmospheric windows; principal applications of different wavelength regions; typical spectral reflectance curve for vegetation, soil and water, spectral signatures.	**8**
2	Different types of sensors and platforms; contrast ratio and possible causes of low contrast; aerial photography; types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap; stereoscopic vision, requirements of stereoscopic photographs; air-photo interpretation- interpretation elements;	**8**
3	photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereo-pair- vertical measurements by the parallax method; ground control for aerial photography; satellite remote sensing, multispectral scanner- whiskbroom and push-broom scanner; different types of resolutions; analysis of digital data- image restoration; image enhancement; information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices.	**8**
4	Microwave remote sensing. GI Sand basic components, different sources of spatial data, basic spatial entities, major components of spatial data, Basic classes of map projections and their properties. .	**8**
5	Methods of data input into GIS, Data editing, spatial data models and structures, Attribute data management, integrating data (map overlay) in GIS, Application of remote sensing and GIS for the management of land and water resources.	**8**

Text & Reference Books:

1. Reddy Anji, M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
2. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
3. George Joseph. 2005. Fundamentals of Remote Sensing. 2nd Edition. Universities Press (India) Private Limited, Hyderabad.
4. Jensen, J.R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
5. Lillesand, T., R.W. Kiefer and J. Chipman. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
6. Sabins, F.F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.

ROE 080	**Human Values in Bauddha and Jain Darshan**	**L** 3	**T** 0	**P** 0	**C** 3
Version No.:	2.0 (updated as on June 12th 2019)				
Prerequisite:	RVE 301/401- Universal Human Values and Professional Ethics Desirable- 10 Day Vipassana Meditation course by Shri S. N. Goenka				

Objectives:

1. To help students understand the basic principles of Bauddha and Jain Darshan
2. To help students understand the existential realities including the human existence through Bauddha and Jain 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.

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

1. Understand the basic concepts of Bauddha and Jain Darshan
2. Understand the human being, the needs and activities of human being through Bauddha and Jain Darshan
3. Understand the whole existence
4. Understand the role of human being in the entire existence, thus getting clarity about values at all levels of living and human conduct
5. Understand the foundation of human society and human tradition.

Catalogue Description: Bauddha and Jain Darshan form a part of the philosophy of Indian tradition. This course outlines the basic concepts and principles of these two philosophies and provides scope for further reading of the philosophies, so as to gain clarity about the human being, the existence and human participation i.e. human values expressing itself in human conduct.

It is to be kept in mind that Darshan means realisation 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.

Module I: Introduction to Bauddha and Jain Darshan and their Basics

Need to study Bauddha and Jain Darshan; the origin of the thsee philosophies, their basic principles and scope for further reading.

Module II: Basic Principles of Bauddha Darshan

law of impermanence (changability); four noble truths; eightfold path; law of cause- action (*pratitya-samutpaad*)

Definition of some salient words of Buddha Darshan – *nirvana, dhamma, tri- ratna(Buddha, Dharma and Sangh), pragya, karma, parmi, ashta-kalap, trishna, shad-ayatan, samvedana, vipassana, anitya, maitri, brham-vihaar, tathagata, arahant.*

Module III: Purpose and Program for a Human Being based on Bauddha Darshan

The purpose and program of a human being living on the basis of it, clarity and practice of human values and human conduct, the natural outcome of such a program on society, nature and tradition.

Purpose-freedom from suffering, *nirvana*; root of suffering- *vikaar – raga, dvesha* and *moha,* Progam – various steps of meditation for attaining knowledge; *shamath and vipassana; sheel-samadhi-pragya; practice of equanimity (samatva),* eightfold path(Ashtang Marg); combination of understanding and practice.

Module IV: Basic Principles of Jain Darshan

Basic realities – description of nine elements in existence (*jeev, ajeev, bandh, punya, paap, aashrav, samvar, nirjara, moksha*), 6 dravya of lok – *dharma, adhrma, akash, kaal, pudgal, jeev*; tri-lakshan, various types of *pragya*, various stages of realisation; *samyak-gyan, samyak-darshan, samyak-charitra, syadvaad, anekantavaad, naya- nishchaya and vyavahar, karma-phal siddhanta*

Definition of some salient words of Jain Darshan –*arhant, jin, tirthankara, panch-parameshthi, atma, pramaan, kaal, pudgal, paramanu, kashay, leshya.*

Module V: Purpose and Program for a Human Being based on Jain Darshan

The purpose and program of a human being living on the basis of it, clarity and practice of human values and human conduct, the natural outcome of such a program on society, nature and tradition, possibility of finding solutions to present day problems in the light of it.

Purpose (goal) - *moksha*, Program- following *mahavrat, anuvrat, 10 lakshan dharma; samyak darshan-gyan-charitra.* Commonality with Bauddha Darshan

Text Books:

1. Chattejee, S.G. and Datta, D.M., "*An Introduction to Indian Philosophy*", University of Calcutta Press, 1960.

References:

1. "*Dhammapad*", Vipassana Research Institute, 2001.
2. Drukpa, G., "*Musings from the Heart"*, Drukpa Publications Private Ltd, 2018.
3. Jyot, *"Ek cheez milegi Wonderful"*, A Film Directed by Jyot Foundation, 2013.
4. Goenka, S.N., "The Discourse Summaries", Vipassana Research Institute, 1987.
5. Madhavacharya, "*Sarva-darshan Samgraha"*, Chaukhambha Vidya Bhavan, Varanasi, 1984.
6. Varni, J., "*Samansuttam"*, Sarva Seva Sangh Prakashan, Varanasi, 7th Edition, 2010.
7. https://www.youtube.com/watch?v=cz7QHNvNFfA&list=PLPJVlVRVmhc4Z01fD57jbzycm9I6W054x (English)
8. https://www.youtube.com/watch?v=r5bud1ybBDc&list=PLY9hraHvoLQLCkl7Z2DWKMgRAWU77bKFy (Hindi)

Mode of Evaluation: Assignment/ Seminar/Continuous Assessment Test/Semester End Exam

Open Electives for B.Tech 4th year (CBCS)		
Open Electives I (VII Semester)		
Sl. No.	Subject Code	Name of Elective(s)
1	ROE071	Modelling and Simulation of Dynamic Systems
2	ROE072	Introduction to Smart Grid
3	ROE073	Cloud computing
4	ROE074	Understanding the human being Comprehensively Human Aspiration audits fulfilment
Open Electives II (VIII Semester)		
Sl. No.	Subject Code	Name of Elective(s)
1	ROE081	Digital and Social Media Marketing
2	ROE082	Entrepreneurship Development
3	ROE083	Machine Learning
4	ROE084	Micro and Smart Systems
5	ROE085	Operations Research
6	ROE086	Renewable Energy Resources
7	ROE087	*Human Values in Madhyasth Darshan
8	ROE088	*Values, Relationship & Ethical Human Conduct-For a Happy & Harmonious Society

Note:

1. The Student shall choose an open Elective from the list in such a manner that he/she has not studied the same course in any form during the degree programme.
2. * It is mandatory that for these two subjects (ROE087 & ROE088) only trained Faculty (who had done the FDP for these courses) will teach the courses.

ROE081 DIGITAL AND SOCIAL MEDIA MARKETING L T P 3 0 0

UNIT-I	Introduction to Digital Marketing: The new digital world - trends that are driving shifts from traditional marketing practices to digital marketing practices, the modern digital consumer and new consumer's digital journey. Marketing strategies for the digital world-latest practices.
UNIT-II	Social Media Marketing -Introduction to Blogging, Create a blog post for your project. Include headline, imagery, links and post, Content Planning and writing. Introduction to Face book, Twitter, Google +, LinkedIn, YouTube, Instagram and Pinterest; their channel advertising and campaigns
UNIT-III	Acquiring & Engaging Users through Digital Channels: Understanding the relationship between content and branding and its impact on sales, search engine marketing, mobile marketing, video marketing, and social-media marketing. Marketing gamification, Online campaign management; using marketing analytic tools to segment, target and position; overview of search engine optimization (SEO).
UNIT-IV	Designing Organization for Digital Success: Digital transformation, digital leadership principles, online P.R. and reputation management. ROI of digital strategies, how digital marketing is adding value to business, and evaluating cost effectiveness of digital strategies
UNIT-V	Digital Innovation and Trends: The contemporary digital revolution, digital transformation framework; security and privatization issues with digital marketing Understanding trends in digital marketing – Indian and global context, online communities and co-creation,

Text books:

1. Moutsy Maiti: Internet Mareting, Oxford University Press India
2. Vandana, Ahuja; Digital Marketing, Oxford University Press India (November, 2015).
3. Eric Greenberg, and Kates, Alexander; Strategic Digital Marketing: Top Digital Experts Share the Formula for Tangible Returns on Your Marketing Investment; McGraw-Hill Professional (October, 2013).
4. Ryan, Damian; Understanding Digital Marketing: marketing strategies for engaging the digital generation; Kogan Page (3rd Edition, 2014).
5. Tracy L. Tuten & Michael R. Solomon: Social Media Marketing (Sage Publication)

ROE082 ENTREPRENEURSHIP DEVELOPMENT L T P 3 0 0

UNIT-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.
UNIT-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.
UNIT-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.
UNIT-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 of financial flows, control and communication.
UNIT-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.

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

ROE083 MACHINE LEARNING L T P 3 0 0

UNIT-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
UNIT-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 AlgorithmConvergence, Generalization;
UNIT-III	Evaluating Hypotheses: Estimating Hypotheses Accuracy, Basics of sampling Theory, Comparing Learning Algorithms; Bayesian Learning: Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm;
UNIT-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
UNIT-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.

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.

ROE084 MICRO AND SMART SYSTEMS L T P 3 0 0

UNIT-I	Introduction, Why miniaturization?, Microsystems versus MEMS, Why micro fabrication?, smart materials, structures and systems, integrated Microsystems, applications of smart materials and Microsystems.
UNIT-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.
UNIT-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.
UNIT-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.
UNIT-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.

Text books:

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

ROE085 OPERATIONS RESEARACH L T P 3 0 0

UNIT-I	Introduction: Definition and scope of operations research (OR), OR model, solving the OR model, art of modelling, phases of OR study. Linear Programming: Two variable Linear Programming model and Graphical method of solution, Simplex method, Dual Simplex method, special cases of Linear Programming, duality, sensitivity analysis.
UNIT-II	Transportation Problems: Types of transportation problems, mathematical models , transportation algorithms, Assignment: Allocation and assignment problems and models, processing of job through machines.
UNIT-III	Network Techniques: Shortest path model, minimum spanning Tree Problem, Max-Flow problem and Min-cost problem. Project Management: Phases of project management, guidelines for network construction, CPM and PERT.
UNIT-IV	Theory of Games : Rectangular games, Minimax theorem, graphical solution of 2 x n or m x 2 games, game with mixed strategies, reduction to linear programming model. Quality Systems: Elements of Queuing model, generalized poisson queing model, single server models.
UNIT-V	Inventory Control: Models of inventory, operation of inventory system, quantity discount. Replacement: Replacement models: Equipments that deteriorate with time, equipments that fail with time.

Text books:

1. Wayne L. Winston,"Operations Research" Thomson Learning, 2003.

2. Hamdy H. Taha, "Operations Research-An Introduction" Pearson Education, 2003.

3. R. Panneer Seevam, "Operations Research" PHI Learning, 2008.

4. V.K.Khanna, "Total Quality Management" New Age International, 2008.

ROE086: RENEWABLE ENERGY RESOURCES L T P 3 0 0

UNIT-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.
UNIT-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.
UNIT-III	Geothermal Energy: Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations. Cells: Principle of working of various types of fuel cells and their working, performance and limitations.
UNIT-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.
UNIT-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.

Text books:

1. Raja etal, “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.
7. Godfrey Boyle,“ Renewable Energy Power For A Sustainable Future”, Oxford University Press.

ROE 087	Human Values in Madhyasth Darshan	L	T	P	C
		3	0	0	3
Version No.:	2.0 (updated as on June 12th 2019				
Prerequisite:	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

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

1. Understand the basic concepts of Madhyasth Darshan
2. Understand the human being, the needs and activities of human being through Madhyasth Darshan
3. Understand the whole existence
4. Understand the role of human being in the entire existence, thus getting clarity about values at all levels of living and human conduct
5. Understand the foundation of human society and human tradition.

Catalogue Description: Madhyasth Darshan is a new emerging philosophy that describes the existential realities along with its implication in behaviour 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 realisation 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.

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.

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.

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.

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

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.

Text Books:

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

References:

1. Nagraj, A., "*Vyavaharvadi Samajshastra"*, Jeevan Vidya Prakashan, 2nd edition, 2009.
2. Nagraj, A., "*Avartanasheel Arthashastra"*, Jeevan Vidya Prakashan, 1st edition, 1998.

Mode of Evaluation: Assignment/ Seminar/Continuous Assessment Test/Semester End Exam

ROE088 VALUES, RELATIONSHIP & ETHICAL HUMAN CONDUCT–FOR A HAPPY & HARMONIOUS SOCIETY L T P 3 0 0

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 pre-conditionings and present beliefs.

UNIT-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.

UNIT-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.

UNIT-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.

UNIT-IV

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

UNIT-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.

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 & Harper Collins, 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. Samagra kranti: 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.

Reference Videos.

1. kin school (30 minutes)
2. Technology (Solar City etc.).
3. Natural Farming.
4. Economics of Happiness (1h 8m)