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

(Chemical Engineering)

On

Choice Based Credit System

[Effective from the Session: 2019-20]

B Tech. Chemical Engineering

4th Year VII-SEMESTER **Session- 2019-20**

Sl No.	Subject Code	Subject Name	L-T-P	Th/Lab Marks	Sessional		Total	Credit
					Test	Assig/ Att.		
1		OPEN ELECTIVE COURSE-1	3---0---0	70	20	10	100	3
2		DEPTT ELECTIVE COURSE-3	3---0---0	70	20	10	100	3
3		DEPTT ELECTIVE COURSE-4	3---1---0	70	20	10	100	4
4	RCH701	Process Modeling & Simulation	3---0---0	70	20	10	100	3
5	RCH702	Process Design & Economics	3---1---0	70	20	10	100	4
6	RCH751	CAD Lab	0---0---2	50		50	100	1
7	RCH752	Energy Lab	0---0---2	50		50	100	1
8	RCH753	Industrial Training	0---0---3			100	100	2
9	RCH754	PROJECT-1	0---0---6			200	100	3
	TOTAL						**1000**	**24**

DEPARTMENT ELECTIVE 3:

RCH071: Corrosion Science & Engg
RCH072: IPA & Waste Management
RCH073: Colloid Surface & Interfacial Phenomena
RCH074: Environmental Impact Assessment

DEPARTMENT ELECTIVE 4:

RCH075: Energy Engg. & Management
RCH076: Project Engg & Management
RCH077: Fuel Cell Technology
RCH078: Advance Numerical Analysis

B Tech. Chemical Engineering

4th Year VIII- SEMESTER **Session- 2019-20**

Sl No.	Subject Code	Subject Name	L-T-P	Th/Lab Marks	Sessional		Total	Credit
					Test	Assig/ Att.		
1		Open Elective Course-2	3---0---0	70	20	10	100	3
2		Deptt. Elective Course-5	3---1---0	70	20	10	100	4
3		Deptt Elective Course-6	3---0---0	70	20	10	100	3
4	RCH851	Seminar	0---0---3			100	100	2
5	RCH852	Project-2	0---12---0	350		250	600	12
	TOTAL						**1000**	**24**

DEPARTMENT ELECTIVE 5:

RCH081: Fertilizer Technology
RCH082: Fluidization Engg
RCH083: Multiphase Reactor Design
RCH084: Biochemical Engineering (MOOCs)

DEPARTMENT ELECTIVE 6:

RCH085: Novel Separation Process (MOOCs)
RCH086: Petroleum Refining
RCH087: Petrochemical Technology
RCH088: Polymer Technology

RCH701:Process Modeling & Simulation (3:0:0)

UNIT I

Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models: Linear vs. Nonlinear, Lumped parameter vs. Distributed parameter; Static vs. Dynamic, Continuous vs. Discrete; Numerical Methods: Iterative convergence methods, Numerical integration of ODE- IVP and ODE-BVP.

UNIT II

Concept of degree of freedom analysis: System and its subsystem, System interaction, Degree of freedom in a system e.g. Heat exchanger, Equilibrium still, Reversal of information flow, Design variable selection algorithm, Information flow through subsystems, Structural effects of design variable selection, Persistent Recycle.

UNIT III

Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, - steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries.

UNIT IV

Steady state models giving rise to differential algebraic equation (DAE) systems; Rate based approaches for staged processes; Modeling of differential contactors – distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries. Introduction to unsteady state models and their applications.

UNIT V

Simulation and their approaches, Modular, Sequential, Simultaneous and Equation solving approach, Simulation softwares and their applications, Review of solution techniques and available numerical software libraries. Review of thermodynamic procedures and physical property data banks.

BOOKS:

1. Luyben W.L., “Process Modeling, Simulation, and Control for Chemical Engineering”, Mc Graw Hill.
2. D. F. Rudd and C. C. Watson, “ Strategy of Process Engineering”, Wiley international.
3. M.M. Denn, “Process Modelling”, Wiley, New York, (1990).
4. A. K. Jana, “Chemical Process Modelling and Computer Simulation”, PHI,(2011)
5. C.D. Holland, “Fundamentals of Modelling Separation Processes”, Prentice Hall, (1975)
6. Hussain Asghar, “Chemical Process Simulation”, Wiley Eastern Ltd., New Delhi, (1986)

RCH702: Process Design & Economics (3:1:0)

UNIT-I

Introduction , Basic design procedure and theory , Heat exchanger analysis: the effectiveness NTU method , Overallheat-transfer coefficient , Fouling factors (dirt factors) ,Shell and tube exchangers: construction details , Heat exchangerstandards and codes ,Tubes , Shells , Tube-sheet layout (tube count) ,Shell types (passes) , Shell and tubedesignation ,Baffles , Support plates and tie rods , Tube sheets (plates) ,Shell and header nozzles (branches) ,Flow inducedtube vibrations ,Mean temperature difference (temperature driving force) , Shell and tube exchangers:general design considerations , Fluid allocation: shell or tubes ,Shell and tube fluid velocities ,Stream temperatures , Pressure drop ,Fluid physical properties ,Tube-side heat-transfer coefficient and pressure drop (single phase) ,Heat transfer , Tube-side pressure drop ,Shell-side heat-transfer and pressure drop (single phase) ,Flow

pattern , Design methods ,Kern's method ,Bell's method , Shell and bundle geometry ,Effect of fouling on pressure drop , Pressure droplimitations.

UNIT –II

Condensers ,Heat-transfer fundamentals , Condensation outside horizontal tubes ,Condensation inside and outside vertical tubes , Condensation inside horizontal tubes , Condensation of steam , Mean temperature difference , Desuperheating and sub-cooling Condensation of mixtures Pressure drop in condensers , Design of forced circulation reboilers , Design of thermosyphon reboilers ,Design of kettle reboilers , Heat transfer to vessels Jacketed vessels , Internal coils , Agitated vessels .

UNIT –III

Design methods for binary distillation systems , Basic equations , McCabe-Thiele method ,Low product concentrations , The Smoker equations ,Batch distillation , Steam distillation, Plate efficiency, Prediction of plate efficiency :O'Connell's correlation , Van Winkle's correlation , AIChE method , Entrainment , Approximate column sizing , Plate contactors , Selection of plate type , Plate construction , Plate hydraulic design,Plate-design procedure, Plate areas ,Diameter , Liquid-flow arrangement ,Entrainment ,Weep point , Weir liquid crest , Weir dimensions , Perforated area , Hole size , Hole pitch ,Hydraulic gradient ,Liquid throw , Plate pressure drop , Downcomer design

UNIT–IV

Design of packed columns for absorption/stripping, Types of packing, Packed-bed height- Prediction of the height of a transfer unit (HTU), Prediction of the number of transfer units (NTU), Column diameter (capacity) , Column internals , Wetting rates , Column auxiliaries

UNIT –V

Analysis of Cost Estimates: Factors affecting investment and production costs, Capital investment, Types of capital cost estimates, Methods for estimating capital investment, Estimation of Revenue, Estimation of total product cost, Gross Profit, Net Profit and Cash flow Simple and Compound interest, Loan Payments, Cash flow pattern –Discrete cash flow & Continuous cash flow, Profitability, Alternative investments by different profitability methods, Effect of inflation on profitability analysis, Methods of profitability evaluation for replacements. Depreciation: Straight line, Declining balance, Double declining balance, sum-of-the-digit, Sinking-fund, Accelerated cost recovery system, Modified accelerated cost recovery system.

BOOKS:

1. Towler G. and Sinnott R. K., "Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design", Butterworth-Heinemann.2008

2. Seader J. D. and Henley E. J., "Separation Process Principles", 2nd Ed., Wiley-India.2006

3. I.S.: 4503-1967, "Indian Standard Specification for Shell and Tube Type Heat Exchangers", Bureau of Indian Standards.2007

4. Hewitt G. F., Shires G. L. and Bott T. R., "Process Heat Transfer", CRC Press.1994

5. Serth R.W., "Process Heat Transfer: Principles and Applications", Academic Press.2007

6. Coker A. K., "Ludwig's Applied Process Design for Chemical and Petrochemical Plants", Vol. 1, 4th Ed., Gulf Publishers.2007

7. Ludwig E. E., "Applied Process Design for Chemical and Petrochemical Plants", Vol. 2, 3rd Ed., Gulf Publishers.1997

8. Ludwig E. E., "Applied Process Design for Chemical and Petrochemical Plants", Vol. 3, 3rd Ed., Gulf Publishers.

9. Peters M. S. and Timmerhaus K. D., "Plant Design And Economics For Chemical Engineers", 5th Ed., McGraw Hill, International Ed.2004

RCH751: CAD Lab (0:0:2)

1. Solve a non-linear algebraic equation using Newton-Raphson's method.
2. Calculate pressure drop in pipe.
3. Calculate minimum fluidization velocity.
4. Calculate terminal velocity.
5. Solve a system of non-linear equations,
6. Calculate the molar volume of saturated liquid water and saturated water vapour using van der

1. Waals, Redlich-Kwong and Peng-Robinson cubic equation of state.
2. Solve system of simultaneous ordinary differential equations.
3. Solve for outlet temperatures of series of stirred tanks with coil heater.
4. Solve for non-isothermal PFR.
5. Solve for concentration profiles of A, B and C in the series reaction A→B→C.

RCH752: Energy Lab (0:0:2)

1. Determination of composting of the supplied sample of Coal by Proximate Analysis.
2. To find the effect to temperature on viscosity of the supplied samples of liquid fuel using Red wood viscometer/ lubricating oil using Engler's Viscometer.
3. To find the Flash and Fire point of the supplied samples of liquid fuel using (i) Penslery Martein closed cup apparatus (ii) Abel open cup apparatus.
4. To find the Aniline point of the supplied samples of liquid fuels using Aniline point apparatus and hence find out the Diesel Index Number of the Diesel oil.
5. To find the moisture content of the supplied samples of liquid fuel/ Crude oil using Dean and Stark apparatus.
6. To find the Pour point and Solidification point of the supplied samples of liquid fuels.
7. To determine the Gross calorific value of the supplied sample of coal using Bomb Calorimeter (on ash free basis).
8. To determine the Smoke Point of Kerosene oil using Smoke Point apparatus.

RCH753: Industrial Training (0:0:3)

The students must submit the report to their institute complete 4 week Industrial Training after the completion of their 6^{th} semester. Students may opt this course at any Industry/ Research Lab for 4 weeks.

RCH754: PROJECT – 1 (0:0:6)

The students would be allotted an industrial project or any Research Project in the beginning of the VII semester itself. He/ She may continue this project in details, later in the (8^{th}) semester. The assessment of ESE will be done the faculty member of the other department within the same institute.

DEPARTMENT ELECTIVE 3:

RCH071:Corrosion Science & Engg (3:0:0)

UNIT I

Basic aspects introduction, classification, economics and cost of corrosion. Emf series, Galvanicseries,corrosion theories derivation of potential- current relationship of activation controlled and diffusioncorrosion processes. Potential- pH diagrams Fe-H2O system, application and limitations. Passivationdefinition, anodic Passivation, theory of Passivation, oxidation laws, effects of oxygen and alloying onoxidation rates.

UNIT II

Forms of corrosion-definition, factors and control methods of various forms of corrosion such as pitting,inter granular, crevice, stress corrosion, corrosion fatigue, hydrogen embrittlement, corrosion processesand control methods in fertilizers, petrochemical and petroleum refineries

UNIT III

Environmental aspects: Atmospheric corrosion- classification, factors influencing atmospheric corrosion,temporary corrosion preventive methods, corrosion in immersed condition, effect of dissolved gases,salts, pH, temperature and flow rates on corrosion, Underground corrosion- corrosion process in the soil,factors influencing soil corrosion.

UNIT IV

Corrosion control aspects: Electrochemical methods of protection-theory of cathodic protection, design ofcathodic protection, sacrificial anodes, anodic protection. Corrosion inhibitors for acidic, neutral andalkaline media, cooling water system-boiler water system. Organic coating-surface preparation, naturalsynthetic resin, paint formulation and applications. Design aspects in corrosion prevention, corrosionresistant materials.

UNIT V

Corrosion Testing, monitoring and inspection, laboratory corrosion tests, accelerated chemical tests forstudying different forms of corrosion. Electrochemical methods of corrosion rate measurements by DCand AC methods, corrosions monitoring methods, chemical and electrochemical removal of corrosionproducts.

BOOKS:

1. S.N. Banerjee, An Introduction to Corrosion and Corrosion Inhibition,
Oxonian Press Ltd., New Delhi.
2. LL Shrier Corrosion Vol. I & II George NownonsLtd., Southhampton Street London Endn. II
3. M.G. Fontana & N.D. Greene,Corrosion Engineering, McGraw Hill, New York (3/e)
4. H.H. Uhlig, Corrosion and Corrosion Control. A Wiley- Inter Science. Publication John Wiley & Sons, New York.
5. C.T.Munger- Organic Coatings
6. Jain & Jain, Engineering Chemistry, Dhanpat Rai & Sons, New Delhi

RCH072:IPA & Waste Management (3:0:0)

UNIT I

Introduction: Industrial Pollution and types of pollution from chemical process industries, Characterization of emission and effluents, Global consideration of environmental pollution,

Environmental legislation - Water Act 1974, Air Act 1981, Environmental Protection Act 1986;Standards for liquid effluents from chemical process industries, air quality, nuclear radiationemission, noise emission.

UNIT II

Pollution Prevention: Process modification, Alternative raw material, Recovery of by productfrom industrial emission/effluents, Recycle and reuse of waste, Energy recovery and wasteutilization, Material and energy balance for pollution minimization, Water minimization,Fugitive emission/effluents and leakages and their control-housekeeping and maintenance.

UNIT III

Air Pollution Control: Air pollutants classification, Equipments for controlling particulate andgaseous pollutants, lapse rate, atmospheric stability, Dispersion models, Plume behavior, Stackdesign, Design of gravity settling chamber, cyclones, electrostatic precipitator, fabric filters andabsorbers, Air pollution control for petroleum refineries and cement plants.

UNIT IV

Water Pollution Control: Waste water characteristics, Primary, secondary and tertiary treatments for wastewater, Anaerobic and aerobic treatment biochemical kinetics, Design of trickling filter, activated sludge systems, ponds and lagoons and aeration systems, Water pollution control for petroleum refineries, fertilizer industry, pulp and paper industry.

UNIT V

Solid Waste Management: Characterization of solid wastes-hazardous and non-hazardous wastes, Waste disposal and management laws and guidelines, Non-hazardous industrial wastestreatment,disposal, utilization and management, Value-extraction from the wastes, Handling,storage and disposal of hazardous wastes, Waste disposal for nuclear power plants.

BOOKS:

1. Metcalf & Eddy, "Wastewater Engineering - Treatment and Reuse", Revised by G. Tchobanoglous, F. L. Burton, and H. D. Stensel, 4th edition. Tata McGraw-Hill, 2003.
2. Mahajan S. P., Pollution control in process industries, Tata McGraw-Hill, 1985
3. Peavy H.S., Rowe D.R. and Tchobanoglous G., Environmental Engineering, McGraw-Hill edition, 1985
4. Kreith F. and Tchobanoglous G., "Handbook of Solid Waste Management", 2nd Ed., Mc Graw Hill, 2002
5. Pichtel J., "Waste Management Practices: Municipal, Hazardous and Industrial", CRC, 2005

RCH073:Colloid Surface & Interfacial Phenomena (3:0:0)

UNIT I

Surface tension, adhesion and capillarity

Effects of confinement and finite size, concepts of surface and interfacial energies and tensions,

Apolar (aan der Waals) and polar (acid-base) components of interfacial tensions. Young-Laplace

equation of capillarity, examples of equilibrium surfaces, multiplicity, etc., Stability of equilibrium solutions, contact angle and Young's equation, Determination of aploar (van der Waals) and acid-base components of surface/interfacial tensions. Free energies of adhesion, kinetics of capillary and confined flow.

UNIT II

Intermolecular, nanoscale and interfacial forces in organic, polymeric, biological and aqueous systems

Van der waals, electrostatic double layer, acid-base interactios including hydrophobic attraction
and hydration pressure

UNIT III

Mesoscale thermodynamics and Mesoscale phenomena in soft matter & applications

Gibb's treatment of interfaces, concept of excess concentration, variation of interfacial tension
with surface concentration, Adhesion, wetting, nucleation, flotation, patterning of soft material
by self organization and other techniques.

UNIT IV

Stability of nanoparticle dispersions

DLVO and DLVO like theories and kinetics of coagulation plus general principles of diffusion in
a potential field/Brownian movement.

UNIT V

Nanofluidics and Advanced & Functional Interfaces

Stability of thin (< 100 nm) film, self-organization in confined systems, mesoscale patterning. Superhydrophobicity, functionsl coatings, structural colours, nano-adhesives, nano-composites.

BOOKS:

1. Principles of Colloid and Surface Chemistry, Paul C. Hiemenz, Marcel DEker, 2nd edition and ionwards, 1986.
2. Physical Chemistry of Surfaces, Arthur W. Adamson, 5th edition, Wiley, 1990.
3. Foundations of Colloid Science, Robert J. Hunter, Clarendons, Oxford, Volume 1, 1989.
4. Colloidal Dispersions, W. B. Russel, D. A. Saville, and W, R. Schowalter, Cambridge University Press, 1989.
5. Intermolucular and Surface forces, Jacon N. Israelachvili, Academic Press, 1992 or later editions.
6. Interfacial Forces in Aqueous Media, Carel J. van Oss, Marcel Dekker or Taylor Francis, 1994.

RCH074:Environmental Impact Assessment(3:0:0)

S. No.	Contents	Contact Hours
1.	**Introduction**: Historical perspective and evolution of guidelines for environmental impact assessment (EIA); Developmental and economic activities and their impact on environmental quality; Carrying capacity and sustainable development.	4
2.	**Environmental Impact Policy**: Guidelines for EIA for various developmental activities, environmental indices and indicators; Operational framework, rapid and comprehensive EIA. Environmental review and screening of projects, public hearing, scoping and baseline studies; Projects requiring EIA.	6
3.	**Monitoring and Analysis of Environmental Quality**: Monitoring and analysis of wastewater, surface water, ground water, ambient air and emissions; Micro-meteorology, atmospheric dispersion; Noise level monitoring and modeling;	8
4.	**Environmental Impacts**: Impact of developmental activities on environmental components and their analysis, quality of air, water and land and their impact on biodiversity, socioeconomic and cultural/ethical aspects and their interconnectivity.	8
5.	**Environmental Impact Assessment Methodologies**: Modeling and prediction, impact valuation and composite impact analysis and assessment.	6
6.	**Environmental Management Plan**: Protective and preventive planning, cost-benefit analysis, environmental management plan (EMP) and disaster management plan (DMP), on-site and off-site management plan, forest management plan and green-belt design. Post project monitoring.	5

S. No.	Authors / Name of Book / Publisher	Year of Publication
1.	Canter L.W., "Environmental Impact Assessment", McGraw Hill.	1996
2.	Rau J.G. and David C., "Environmental Impact Analysis Handbook", McGraw Hill.	1980
3.	"Guidelines for EIA of Industrial and other Projects" Ministry of Environment and Forests, Government of India.	2009
4.	Cheremisinoff P.N. and Morresi A.C., "Environmental Assessment and Impact Statement Handbook", Ann Arbor.	1977
5.	Pollution Control Law Series: Pollution Control Acts, Rules and Notification Issued There under, Central Pollution Control Board, Ministry of Environment and Forest, Government of India.	2006

DEPARTMENT ELECTIVE 4:

RCH075:Energy Engg. & Management (3:1:0)

UNIT I

Energy Scenario: Indian and global, energy crisis, Classification of various energy sources, Renewable and non-renewable energy sources, Remedial measures to some energy crisis. EnergyConservation.

UNIT II

Alternative Sources of Energy : Fuel cell ,Solar Energy : Photo thermal and photovoltaic conversion and utilization methods , solar water heating , cooking , drying and its use for otherindustrial processes ,solar cells their material and mode of operation . direct and indirect methodssolar energystorage , sensible heat and latent heat storage materials Solar ponds .Bio energy,Biogas plants and their operation , Biomass and its conversion roots to gaseous and liquid fuels, Wind energy , its potential and generation by wind mills.

UNIT III

Hydroelectric potential, its utilization & production, Geothermal energy its potential status andproduction, Nuclear energy : Status, nuclear raw materials, nuclear reactors and otherclassification, Generation of Nuclear power, Nuclear installations in India and their capacity ofgeneration, Limitations of nuclear energy, Reprocessing of spent nuclear fuel, Cogeneration offuel and power, Energy from tidal and ocean thermal sources, MHD systems.

UNIT IV

Fossil and Processed Fuel: Coal its origin and formation, Coal analysis, Coal classification, Coal preparation, Coal washing and coal blending, Coal carbonization, Treatment of coal gas andrecovery of chemical from coal tar, Coal gasification, liquid fuel synthesis from coal, CBM.

UNIT V

Petroleum crude , Types of crude ,emergence of petroleum products as energy, GaseousFuels:

Natural gas, Water gas, producer gas, L.P.G., bio- gas, coke oven gas, blast furnace gas, LNG,CNG,Gas hydrates ,GTL Technology (gas to liquid), Bio-diesel.

BOOKS:

1. Brame J.S.S. and King J.G., Edward Arnold “Fuel Solid, Liquid and Gases” Edward Arnold (1967).
2. Sukhatme S.P, "Solar Energy - Principles of Thermal Collection and Storage",2nd Ed., Tata McGraw- Hill.,(1996).

RCH076:Project Engg & Management (3:1:0)

Unit 1

Project identification, preliminary techno-economic feasibility, laboratory development and research, pilot plant level studies, scale-up methods. Process selection, alternative process. Flow sheet preparation, different components of PFD, equipment numbering, stream designation, battery limit and off sites.

Unit 2

Selection of process equipments. standard versus special equipments, selection Criteria, specification sheet of equipment, Process auxiliaries-Piping design, layout, process control and instrumentation, Process utilities process water, boiler-feed water, waste treatment & disposal, oil heating system, chilling plant, compressed air, instrument air.

Unit 3

Interest – types & calculations, Cost estimation – factors involved in project cost estimation, total capital investment, fixed capital and working capital, process equipment cost estimation. Cost index and scaling for equipment cost. Estimation of total product cost-factors involved.

Unit 4

Depreciation – type & methods of determination, Profitability-criteria of profitability, Payout period, return on investment, present value, cash flow analysis, alternative investment and replacement methods, factors in alternative & replacement investment, project profitability analysis.

Unit 5

Project management, scheduling a project using CPM/ PERT, Inventory control methods, Optimum conditions- productions schedule, optimum production rates in plant operations, optimum conditions in batch and cyclic operations, Design reports, Plant location and layout principles – factors involved, case studies for specific plants.

Text Books:

1. Peters, M.S. and Timmerhaus, K.D., " Plant Design & Economics for Chemical Engineers", McGraw Hill
2. Vilbrabdt and Dryden, "Chemical Engineering Plant Design", McGraw Hill.
3. Ulrich, G.D., :A guide to Chemical Engineering Process Design & Economics", John Wiley and Sons.

RCH077: Fuel Cell Technology (3:1:0)

Unit I

Introduction

Basic principles - classifications - heat of reactions - enthalpy of formation of substances - Gibbs free energy of substances - Efficiency - power - heat due to entropy change and internal ohmic heating.

Unit II

Fuel cell charge and mass transport

Nernst equation and open circuit potential - pressure and temperature effect - Stoichiometric coefficients and reactants utilization - Mass flow rate calculation - voltage and current in parallel and serial connection.

Unit III

Polarization

Over potentials and polarizations - Activation polarization - Tafel equation and exchange current density. Ionic conductivity - catalysts - Temperature and humidification effect - electro-osmotic Drag effect.

Unit IV

Fuel Cell stacks

PEM Fuel cell stacks - Rate of mass transfer of reactants and products - water management - current collections and gas removal - Bipolar plates - flow distribution - Heat and water removal from the stack.

Unit V

Designing

Fuel cell systems analyze: Energy systems - power - Train or Drive - Train Analysis - PEMFC powered Bus - Flow Sheet and conceptual Design-Detailed Engineering Designs.

TEXT BOOKS

1. James Larminie, J., Dicks, A. (2003), Fuel Cell Systems Explained, 2nd Edition, John Wiley & Sons Inc., New Jersey, ISBN: 9780470848579.
2. Ryan O'Hayre, Suk-Won Cha, Colella, W., Prinz, F. B. (2009), Fuel Cell Fundamentals, Wiley, New Jersey,ISBN: 9780470258439.

REFERENCE BOOKS

1. Gregor Hoogers, (2003), Fuel Cell Technology Handbook, CRC Press, New Jersey, ISBN: 9780849308772.
2. Revankar, S., Majumdar, P. (2014), Fuel Cells Principles Design and Analysis, CRC Press, New Delhi, ISBN: 9781420089684.

RCH078: Advanced Numerical Analysis (3:1:0)

Lecture (1 hr)	Contents (Sections from a module, which are relevant for each lecture, are indicated in the last column)	
	Module 1: Equation Forms in Process Modeling	**Sections**
1	Introduction and Motivation, Linear and Nonlinear Algebraic Equation	1,2.12.2
2	Optimization based Formulations, ODE-IVPs and Differential Algebraic Equations	2.3,2.4, 3
3	ODE-BVPs and PDEs	4
4	ODE-BVPs and PDEs, Abstract model forms	4,5
	Module 2: Fundamentals of Vector Spaces	**Sections**

5	Generalized concepts of vector space, sub-space, linear dependence	1,2
6	Concept of basis, dimension, norms defined on general vector spaces	2
7	Examples of norms defined on different vector spaces, Cauchy sequence and convergence, introduction to concept of completeness and Banach spaces	3
8	Inner product in a general vector space, Inner-product spaces and their examples,	4
9	Cauchy-Schwartz inequality and orthogonal sets	4
10	Gram-Schmidt process and generation of orthogonal basis, well known orthogonal basis	5
11	Matrix norms	6

	Module 3: Problem Discretization Using Approximation Theory	**Sections**
12	Transformations and unified view of problems through the concept of transformations, classification of problems in numerical analysis, Problem discretization using approximation theory	1,2
13	Weierstrass theorem and polynomial approximations, Taylor series approximation	2, 3.1
14	Finite difference method for solving ODE-BVPs with examples	3.2
15	Finite difference method for solving PDEs with examples	3.3
16	Newton's Method for solving nonlinear algebraic equation as an application of multivariable Taylor series, Introduction to polynomial interpolation	3.4
17	Polynomial and function interpolations, Orthogonal Collocations method for solving ODE-BVPs	4.1,4.2,4.3
18	Orthogonal Collocations method for solving ODE-BVPs with examples	4.4
19	Orthogonal Collocations method for solving PDEs with examples	4.5
20	Necessary and sufficient conditions for unconstrained multivariate optimization, Least square approximations	8
21	Formulation and derivation of weighted linear least square estimation, Geormtraic interpretation of least squares	5.1,5.2
22	Projections and least square solution, Function approximations and normal equation in any inner product space	5.3
23	Model Parameter Estimation using linear least squares method, Gauss Newton Method	5.4
24	Method of least squares for solving ODE-BVP	5.5
25	Gelarkin's method and generic equation forms arising in problem discretization	5.5
26	Errors in Discretization, Generaic equation forms in transformed problems	6,7

	Module 4: Solving Linear Algebraic Equations	**Sections**
27	System of linear algebraic equations, conditions for existence of solution - geometric interpretations (row picture and column picture), review of concepts of rank and fundamental theorem of linear algebra	1,2
28	Classification of solution approaches as direct and iterative, review of Gaussian elimination	3
29	Introduction to methods for solving sparse linear systems: Thomas algorithm for tridiagonal and block tridiagonal matrices	4
30	Block-diagonal, triangular and block-triangular systems, solution by matrix decomposition	4
31	Iterative methods: Derivation of Jacobi, Gauss-Siedel and successive over-relaxation methods	5.1

32	Convergence of iterative solution schemes: analysis of asymptotic behavior of linear difference equations using eigen values	9
33	Convergence of iterative solution schemes with examples	5.2
34	Convergence of iterative solution schemes, Optimization based solution of linear algebraic equations	
35	Matrix conditioning, examples of well conditioned and ill-conditioned linear systems	7

	Module 5: Solving Nonlinear Algebraic Equations	**Sections**
36	Method of successive substitutions derivative free iterative solution approaches	1,2
37	Secant method, regula falsi method and Wegsteine iterations	3.1,3.2
38	Modified Newton's method and qausi-Newton method with Broyden's update	3.3, 3.4, 3.5
39	Optimization based formulations and Leverberg-Marquardt method	4
40	Contraction mapping principle and introduction to convergence analysis (Optional lecture)	6

	Module 6: Solving Ordinary Differential Equations – Initial Value Problems (ODE-IVPs)	**Sections**
39	Introduction, Existence of Solutions (optional topic),	
40	Analytical Solutions of Linear ODE-IVPs	3
41	Analytical Solutions of Linear ODE-IVPs (contd.), Basic concepts in numerical solutions of ODE-IVP: step size and marching, concept of implicit and explicit methods	4
42	Taylor series based and Runge-Kutta methods: derivation and examples	5
43	Runge-Kutta methods	5
44	Multi-step (predictor-corrector) approaches: derivations and examples	6.1
45	Multi-step (predictor-corrector) approaches: derivations and examples	6.1
46	Stability of ODE-IVP solvers, choice of step size and stability envelopes	7.1,7.2
47	Stability of ODE-IVP solvers (contd.), stiffness and variable step size implementation	7.3,7.4
48	Introduction to solution methods for differential algebraic equations (DAEs)	8
49	Single shooting method for solving ODE-BVPs	9
50	Review	

REFERENCES

1. Gilbert Strang, Linear Algebra and Its Applications (4th Ed.), Wellesley Cambridge Press (2009).
2. Philips, G. M.,Taylor, P. J. ; Theory and Applications of Numerical Analysis (2nd Ed.), Academic Press, 1996.
3. Gourdin, A. and M Boumhrat; Applied Numerical Methods. Prentice Hall India, New Delhi, (2000).
4. Gupta, S. K.; Numerical Methods for Engineers. Wiley Eastern, New Delhi, 1995.

RCH851: Seminar (0:0:3)

Students have to present a detailed power point presentation on their own project topics. Tjis seminar will help them to enhance their personality.

RCH852: Project-2 (0:12:0)

This project course may be in continuation of Project-I (RCH-754) allotted in the beginning of the VII semester. Here, the students are supposed to do the detailed work as scheduled in the last semester. Finally, he/she will be required to submit the detailed project report on which viva-voice examination will be conducted by a committee having at least one external examiner.

DEPARTMENT ELECTIVE 5:

RCH081: Fertilizer Technology (3:1:0)

Unit 1
Introduction of Indian fertilizer industries, types of fertilizers process details.

Unit 2
Manufacture of Nitrogeneous, Phosphatic, potassic, complex, NPK, mixed, Dio and other fertilizers.

Unit 3
Discussion of existing Indian plants pollution and its control, abetment and disposal of waste of fertilizer units.

Unit 4
Retrofits and modernization, computer control and Instrumentation, Energy conservation and diversification.

Unit 5
Design of Ammonia converters and other reactors, cooling water, expansion, capacity utilization and other problem of fertilizers industry.

Books:

1. Mortvedt J. J., Murphy L. S. & Follett R. H., Fertilizer Technology & Application, Meister Publishing Company
2. Shreves Chemical Process Industries, McGraw Hill
3. Drydens Outlines of Chemical Technology, East West Press

RCH082: Fluidization Engg (3:1:0)

UNIT I

Importance of fluidization in process industry, comparison of fluidized beds with other modes of contacting, advantages and disadvantages, industrial applications.

Fluidization and Mapping of Regimes : Fixed bed of particles of one and mixed sizes, fluidization with and without carryover of particles, minimum fluidization, terminal velocity of particles, pneumatic transport of solids, mapping of regimes, Distributors for dense beds, types and design, power consumption for fluidized beds

UNIT II

Bubble Behavior and Bed Properties : Single rising bubble models, wake region and solids within bubbles, interaction and coalescence of bubbles, bubble formation, slug flow.

Bubbling Fluidized Beds : Emulsion phase, gas flow, bubble properties, physical and flow models.

UNIT III

Entrainment and Elutriation From Eluidized Beds : Free boards behavior, gas outlet location, entertainment from tall and short vessels.

Hight Velocity Fluidization : Turbulent fluidized beds, fast fluidization, pressure drop in turbulent and fast fluidization

UNIT IV

Spouted Beds : Hydrodynamics and processing in spouted beds.

Circulation Systems : Circuits for the circulation of solids, pressure balance, flow of gas-solid mixtures in downcomers, flow in pneumatic transport lines.

UNIT V

Design for Physical Operations: Design of single stage and multistage systems, heat and mass transfer, fluid bed drier

LIST OF RECOMMENDED BOOKS

1. Kunii, D. and Levenspiel, O., “Fluidization Engineering”, II ed. Butterworth – Heinemann, (1991)
2. Davidson, D. and Harrison, J.F., “Fluidization Engineering”, II ed. Academic Press (1992)

RCH083: Multiphase Reactor Design (3:1:0)

Unit I

Introduction to advanced reactor analysis tools, Role of Multiphase Reactors, Catalysis, Catalysis, Heterogeneous Catalysis, Homogeneous Catalysis, Parameters Concerning Catalyst Effectiveness in Industrial Operations, Importance of Advanced Instrumental Techniques in Understanding Catalytic Phenomena, Role of Nanotechnology in Catalysis, Role of Multiphase Reactors.

Unit II

The Scale-Up Conundrum, Intrinsic Kinetics: Invariance with Respect to Type/Size of Multiphase Reactor, Transport Processes: Dependence on Type/Size of Multiphase Reactor, Prediction of the Rate-Controlling Step in the Industrial Reactor, Laboratory Methods for Discerning Intrinsic Kinetics of Multiphase Reactions, Two-Phase (Gas–Liquid) Reaction, Three-Phase (Gas–Liquid–Solid) Reactions with Solid Phase Acting as Catalyst

Unit III

Classification of Multiphase Reactors, Criteria for Reactor Selection, Material of Construction, Some Examples of Large-Scale Applications of Multiphase Reactors: Fischer–Tropsch Synthesis and Oxidation of p-Xylene to Purified Terephthalic Acid for Poly(Ethylene Terephthalate), Fluid Turbulence, Eddy Size Distribution and Effect of Eddy Size on Transport Rates, States of Similarity of Relevance to Chemical Process Equipments.

Unit IV

Mass Transfer in Multiphase Reactors: Empirical Correlations Using Operating Parameters and Physical Properties, Correlations Based on Mechanical Similarity, Correlations Based on Dynamic Similarity; Correlations Based on Hydrodynamic/Turbulence Regime Similarity, The Slip Velocity Approach, Approach Based on Analogy between Momentum and Mass Transfer; The Standard Stirred Tank, Power Requirements of Different Impellers; Hydrodynamic Regimes in Two-Phase (Gas–Liquid) Stirred Tank Reactors.

Unit V

Hydrodynamic Regimes in Three-Phase (Gas–Liquid–Solid) Stirred Tank Reactors: Gas Holdup in Stirred Tank Reactors, Relative Gas Dispersion (N/NCD) as a Correlating Parameter for Gas Holdup, Gas–Liquid Mass Transfer Coefficient in Stirred Tank Reactor,
Solid–Liquid Mass Transfer Coefficient in Stirred Tank Reactor: Solid Suspension in Stirred Tank Reactor, Design of Stirred Tank Reactors with Internal Cooling Coils, Gas–Liquid Mass Transfer Coefficient, Solid–Liquid Mass Transfer Coefficient , Stirred Tank Reactor with Internal Draft Tube, Worked Example: Design of Stirred Reactor for Hydrogenation of Aniline to Cyclohexylamine (Capacity: 25000 Metric Tonnes per Year), Elucidation of the Output

TEXT BOOKS

1. Vishwas Govind Pangarkar (2014), Design of Multiphase Reactors, 1st Edition, John Wiley & Sons, Inc., ISBN:978-1-118-80776-7.

2. Octave Levenspiel(2008), Chemical Reaction Engineering, Edition 3, John Wiley & Sons, ISBN:978-81-265-1000-9.

RCH084: Biochemical Engg (3:1:0) (MOOCs)

COURSE DETAIL

S.No	Topics	No. of Lectures
1	Basics of Biology; Overview of Biotechnology; Diversity in Microbial Cells, Cell Constituents, Chemicals for Life **(Dr. Rintu Banerjee).**	7
2	Kinetics of Enzyme Catalysis **(Dr. Saikat Chakraborty)**.	5
3	Immobilized Enzymes: effects of intra and inter-phase mass transfer on enzyme kinetics **(Dr. Saikat Chakraborty)**.	5
4	Major Metabolic Pathways: Bioenergetics, Glucose Metabolism, Biosynthesis **(Dr. Rintu Banerjee)**.	5
5	Microbial Growth: Continuum and Stochastic Models **(Dr. Saikat Chakraborty)**.	3
6	Design, Analysis and Stability of Bioreactors **(Dr. Saikat Chakraborty)**.	4
7	Kinetics of Receptor-Ligand Binding **(Dr. Saikat Chakraborty)**.	3
8	Receptor-mediated Endocytosis **(Dr. Saikat Chakraborty)**.	3
9	Multiple Interacting Microbial Population: Prey-Predator Models **(Dr. Saikat Chakraborty)**.	1
10	Bio-product Recovery & Bio-separations; Manufacture of Biochemical Products **(Dr. Rintu Banerjee)**.	4

REFERENCES

1. Biochemical Engineering Fundamentals by J. E. Bailey & D. F. Ollis, McGraw Hill Book Company, 1986.
2. Biochemical Engineering by H. W. Blanch & D. S. Clark, Marcel Dekker, Inc., 1997.
3. Bioprocess Engineering (Basic Concepts) by M. L. Shuler & F. Kargi, Prentice Hall of India, 2003.

DEPARTMENT ELECTIVE 6:

RCH085: Novel Separation Process (3:0:0) (MOOCs)

COURSE DETAIL

S.No	Topics	No. of Hours
1	Fundamentals of Separation Processes.	1
2	Basic definitions of relevant terms.	1
3	Membrane based separation processes: Fundamentals and various terms. Classifications. Design aspects: various models and their applicabilities.	20
4	External field induced membrane separation processes for colloidal particles: Fundamentals of various colloid separation. Derivation of profile of electric field strength. Coupling with membrane separation and electrophoresis.	6
5	Gas separation.	2
6	Surfactant based separation processes: Liquid membranes: fundamentals and modeling. Micellar enhanced separation processes. Cloud point extraction.	4
7	Centrifugal Separation processes and their calculations.	2
8	Ion exchange and chromatographic separation processes.	2
9	Supercritical fluid extraction.	2
	Total	40

REFERENCES

1. Handbook of Separation Process Technology by R W Rousseau (John Wiley & Sons).
2. Supercritical Fluid Extraction by M A Mchugh & V J Krukonis (Butterworth Heinmann).

3. Large Scale Adsorption & Chromatography by W C Wankat (CRC Press Inc).
4. Advanced Membrane Technology and Applications by N N Li (Wiley).

RCH086: Petroleum Refining (3:0:0)

UNIT I

Petroleum Exploration Production and Refining of Crude oils, Crude oils:Characteristics and constituents of crude oils, Classification of crude oils.

UNIT II

Quality Control of Petroleum Products. Classification of laboratory tests, distillation, vapour pressure, flash and fire points, octane number, performance number, cetane number, aniline point, viscosity index, calorific value, smoke point, char value, viscosity, viscosity index, penetration tests, cloud and pour points, drop point of grease, melting and settling points of wax,softening point of Bitumen, induction period of gasoline, thermal stability of jet fuels, gumcontent, Total Sulphur, Acidity and Alkalinity,, Copper Strip Corrosion Test, Silver – StripCorrosion Test for ATF, Ash, Carbon Residue (Conradson method, Ramsbottom method)Colour, Density and Specific gravity, Refractive index of hydrocarbon liquids, water separationindex (modified) (WSIM), ductility.

UNIT III

Petroleum Products: Composition, Properties & Specification of LPG, Naphthas, motor spirit,Kerosine, Aviation Turbine Fuels, Diesel Fuels, Fuel Oils, Petroleum Hydrocarbon Solvents,Lubricating oils (automotive engine oils, industrial lubricating oils electrical insulating oils, JuteBatching oils, white oils, steam turbine oils, metal working oils, etc.) Petroleum WaxesBitumens, Petroleum coke. **Crude Oil Distillation**: Desalting of crude oils, Atmosphericdistillation of crude oil, Vacuum distillation ofatmospheric residue.Thermal Conversion Process:Thermal Cracking Reactions, Thermal Cracking, Visbreaking, (Conventional Visbreaking andSoaker Visbreaking) Coking (Delayed Coking, Fluid Coking, Flexicoking), Calcination of GreenCoke.

UNIT IV

Catalytic Converson Process: Fluid catalytic cracking; Catalytic reforming; Hydrocracking Catalytic Alkylation, Catalytic Isomerization; Catalytic Polymerization.

Finishing Process: Hydrogen sulphide removal processes; Sulphur conversion processes; Sweetening processes (Caustic treatment, Solutizer process; Doctor treating process; Copper chloride sweetening,; Hypochlorite sweetening ;Air and inhibitor treating process; Merox processes;Sulphuric acid treatment; Clay treatment); Solvent extraction processes (Edeleanu process, Udex process, Sulfolane process), Hydrotreating processes.

UNIT V

Lube Oil Manufacturing Process: Evaluation of crude oils for lube oil base stocks, Vacuum distillation, Solvent deasphalting Solvent extraction of lube oil fractions (Furfural, NMP and Phenol), Solvent dewaxing, Hydrofinshing, Manufacture of petroleum waxes (Wax sweating, Solvent deoiling)

Manufacture of Bitumens: Selection of crude oil, Methods of manufacture of bitumens,

(Distillation, Solvent precipitation, Air blowing).

BOOKS:

1. Ram Prasad, Petroleum Refining Technology, Khanna Publishers, Delhi (2000)
2. Nelson, W.L., Petroleum Refining Engineering, McGraw Hill

RCH087: Petrochemical Technology (3:0:0)

Unit 1
Production and consumption pattern of petrochemicals in India, Feedstocks for petrochemicals-Natural gas, LPG, Refinery off-gases, Hydroforming of petroleum stocks, Naphtha and fuel oils, Petroleum coke

Unit 2
Steam reforming and partial oxidation processes for syngas, Manufacture of Methanol, Formaldehyde, Chloromethanes, Trichloroethylene, Perchloroethylene, Acetic acid, adipic acid

Unit 3
Ethylene and acetylene via steam cracking of hydrocarbons, Manufacture of Ethylene dichloride, Vinyl chloride, Ethylene oxide, Ethanolamines, Acetaldehyde, Vinyl acetate, Ethyl acetate, Ethylene glycol

Unit 4
Manufacture of Isopropanol, Acetone, Methyl ethyl ketone, Methyl isobutyl ketone, Cumene, Acrylonitrile, Propylene oxide, Butadiene, Oxo process

Unit 5
Manufacture of Benzene, Toluene, Xylenes, Phenol, Styrene, Phthalic anhydride, Maleic anhydride, Nitrobenzene, Aniline, Bisphenol-A, Caprolactum

Books Recommended:

1. Mall, I D, Petrochemical Process Technology, McMillan India
2. Rao Bhaskar, Modern Petroleum Refining Processes, Oxford & IBH Publishing
3. Speight J., Chemistry & Technology
4. Robert Mayer, Handbook of Petroleum Refining Processing, McGraw Hill

RCH088: Polymer Technology (3:0:0)

UNIT I

Addition polymers, Condensation polymers, Copolymers, Cross-linked polymers, Molecular symmetry and the tendency to form crystals, Distribution of relative molecular mass, Structure ofthe crystal, Crystal shape, Crystallinity, Crystallization and melting, the glass transitiontemperature, Molecular conformation in the amorphous polymer, the freely jointe chain, theGaussian chain, Molecular orientation.

UNIT II

Structure of an ideal rubber, Entropy elasticity, elasticity of a network, Stress-strain relationship,Engineering rubbers, The nature of visco elasticty, Creep, Stress relaxation, Dynamic properties,Theory of linear viscoelasticity, Polymer selection: stiffness.

UNIT III

Yielding, Crazing, Linear elastic fracture mechanics, Elastic-plastic fracture mechanics, Brittlefracture of polymer, rubber toughening, Reinforced plastics, Forming of reinforced plastics, themechanics of fibre reinforcement, Reinforced rubbers.

UNIT IV

The flow properties of polymer melts, Cooling and solidification, Extrusion, Injection moulding,Compression and transfer moulding.

UNIT V

Materials selection, Designing for manufacture, Designing for stiffness, Designing for strength, Case Histories.

BOOKS:

1. N. G. McCrum, C. P. Buckley and C. B. Bucknall, Principles of Polymer Engineering, 2nd Edition, Oxford University Press, (1997).

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)