UTTARAKHAND TECHNICAL UNIVERSITY, DEHRADUN

M TECH (Power Electronics and Drives) Programme 2018

Semester 1

Sr. No.	Core/Elective	Code	Course name				Credits
				L	T	P	
1	Core 1	(MPDT101)	Electric Drives System	3	0	0	3
2	Core2	(MPDT102)	Modeling and Analysis of Electrical Machines	3	0	0	3
3	PE1	(MPDT111) (MPDT112) (MPDT113) (MPDT114)	1. Advanced Power Electronic Circuits 2.Optimal and Adaptive Control 3.Power Quality 4.Dynamics of Electrical Machines	3	0	0	3
4	PE 2	(MPDT121) (MPDT122) (MPDT123)	1.Static VAR Controllers and Harmonic Filtering 2.PWM converter and Applications 3.Power Semiconductor Devices &Modelling	3	0	0	3
5		(MOET191)	Research Methodology and IPR	2	0	0	2
6	Lab 1	(MPDP101)	Electrical Drives Laboratory	0	0	4	2
7	Lab 2	(MPDP102) (MPDP113)	1.Electrical Machines Laboratory 2.Power Quality lab	0	0	4	2
8	Audit -I	(MAUT191)	Audit I	2	0	0	0
Total Credits 18							

Semester 2

Sr. No.	Core/Elective	Code	Course name				Credits
				L	T	P	
1	Core 3	(MPDT201)	Power Electronic Converters	3	0	0	3
2	Core4	(MPDT202)	1.Digital Control of Power Electronic and Drive Systems	3	0	0	3
3	PE3	(MPDT231) (MPDT232) (MPDT233)	1.Switched Mode and Resonant Converters 2.Industrial Load Modelingand Control 3.Advanced Digital Signal Processing	3	0	0	3
4	PE 4	(MPDT241) (MPDT242) (MPDT243)	1.Advanced Microcontroller based Systems 2.Distributed Generation 3.Smart Grids	3	0	0	3
5		(MPDP202)	Mini Project with seminar	0	0	4	2
6	Lab 3	(MPDP201)	Power Electronics Laboratory	0	0	4	2

7	Lab 4	(MPDP241) (MPDP233)	1.Micro-controller Lab 2.Digital Signal Processing Lab (based on core 4)	0	0	4	2
8	Audit -II	(MAUT292)	Audit II	2	0	0	0
Total Credits 18							

Semester 3

Sr. No.	Core/Elective	Code	Course name				Credits
				L	T	P	
1	PE5	(MPDT351) (MPDT352) (MPDT353)	1.SCADA Systems and Applications 2.FACTS and Custom Power Devices 3.HVDC	3	0	0	3
4	OE	(MOET391) (MOET392) (MOET393) (MOET394) (MOET395) (MOET396)	1. Business Analytics 2. Industrial Safety 3. Operations Research 4. Cost Management of Engineering Projects 5. Composite Materials 6. Waste to Energy	3	0	0	3
5	Major Project	(MPDP301)	Phase- I Dissertation	0	0	20	10
Total Credits 16							

Semester 4

Sr. No.	Core/Elective	Code	Course name				Credits
				L	T	P	
5	Major Project	(MPDP401)	Phase- II Dissertation	0	0	32	16
Total Credits 16							

GRAND TOTAL CREDITS **68**

Programme Outcomes

PO1 Apply the knowledge of science and mathematics in designing, analyzing and using power converters for various industrial and domestic applications.

PO2 Design the modern electric machines, drives, power converters, and control circuitsforspecific application.

PO3 Use modern tools, professional software platforms, embedded systems for thediversified applications.

PO4 Explore ideas for inculcating research skills.

PO5 Solve the problems which need critical and independent thinking to show reflectivelearning.

PO6 Imagine the larger picture and correlate the domain knowledge with the globalindustrialproblems.

Audit course 1 & 2

- English for Research Paper Writing
- Disaster Management
- Sanskrit for Technical Knowledge
- Value Education
- Constitution of India
- Pedagogy Studies
- Stress Management by Yoga
- Personality Development through Life Enlightenment Skills.

FIRST SEMESTER

CORE -1: ELECTRIC DRIVE SYSTEM (MPDT101)

Course Objective :

Students will be able to:

- Understand Basic electrical drives and their analysis.
- Learn Design of controller for drives.
- Understand Scalar control of electrical drives.

Syllabus

Units	Content	Hours
1	Dynamics of Electric Drives: Fundamentals of torque equation. Speed torque convention and ulti-quadrant operation, components of load torques.	5
2	Classification of load torques steady state stability Load equation,Speed control and drive classification. Close loop control of drives.	8
3	DC motor Drives-Modeling of DC machines. Steady state characteristics with armature and speed control Phase controlled DC motor drives, chopper controlled DC motor drives	6
4	Poly-phase induction machines- Dynamic modeling of induction machines.Small signal equations, control characteristics of induction machines. Phase-controlled induction machines.Stator voltage control. Slip energy recovery scheme, frequency control and vector control of induction motor drives.	8
5	Traction motor: Starting , Speed-Time characteristics, Braking Traction motors used in practice Industrial Drives-Digital Control of Electric Drives.	6

6	Stepper motor.Servo motor and their Applications.	8

Suggested reading

1. G.K, Dubey, "Power semiconductor controlled Drives", Prentice Hall international, New Jersey, 1989.
2. R.Krishanam, "Electric motor drives modeling, analysis and control", PHI-India-2009.
3. G. K. Dubey,"Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.
4. W. Leonhard, "Control of Electrical drives", Springer, 3rd edition, 2001.
5. P.C. Krause –, "Analysis of Electric Machine", Wiley-IEEE press 3rdedition.
6. K. Bose,"Modern Power Electronics and AC Drives", Prentice Hall publication, 1st edition, 2001.

Course Outcomes:

Students will be able to:

- Model and simulate electric drive systems
- Design modulation strategies of power electronics converters, for drives application
- Design appropriate current/voltage regulators for electric drives
- Select and implement the drives for Industrial Process

Implement various variable speed drives in Electrical Energy Conversion System

CORE-2: MODELING AND ANALYSIS OF ELECTRICAL MACHINES(MPDT102)

Course Objective

Students will be able to:

- To understand the operation of an electrical machine mathematically.
- To understand how a machine can be represented as its mathematical equivalent.
- To develop mathematical model of AC & DC machines and perform transient analysis on them

Syllabus

Units	Content	Hours
1	Principles of Electromagnetic Energy Conversion. General expression of stored magnetic energy. Co-energy and force/torque, example using single and doubly excited system	5
2	Basic Concepts of Rotating Machines-Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine.	8

3	Three phase symmetrical induction machine and salient pole synchronous machines in phase variable form Application of reference frame theory to three phase symmetrical induction and synchronous machines Dynamic direct and quadrature axis model in arbitrarily rotating reference frames	6
4	Determination of Synchronous machine dynamic equivalent circuit parameters Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine	6
5	Special Machines - Permanent magnet synchronous machine Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines Construction and operating principle	8
6	Dynamic modelling and selfcontrolledoperation.Anal ysis of SwitchReluctance Motors. Brushless D.C. Motor for space Applications Recent trends	8

Suggested reading

- Charles Kingsle,Jr., A.E. Fitzgerald, Stephen D.Umans, "Electric Machinery", Tata Mcgraw Hill
- R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India
- Miller, T.J.E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press
- P.C.Krause "Analysis of Electric Machine" Wiley IEEE Press 3rd Edition

Course Outcomes:

Students will be able to:

- Knowledge about the dynamic behavior rotating machines.
- Able to understand equivalent circuit of synchronous machines.
- To understand various practical issues of different machines.

PE 1: ADVANCED POWER ELECTRONIC CIRCUITS (MPDT111)

Course Objective

Students will be able to:

- Understand the operation of advanced power electronic circuit topologies.
- Understand the control strategies involved.
- Learn few practical circuits, used in practice.

Units	Content	Hours
1	Boost type APFC and control.	5
2	Three phase utility interphases and control-Buck, Boost, Buck-Boost SMPS Topologies. Modes of operation –Push-Pull and Forward Converter Topologies - Voltage Mode Control.	6

3	Half and Full Bridge Converters.Flyback Converter	8
4	Introduction to Resonant Converters. Load Resonant Converter. Zero Voltage Switching Clamped Voltage Topologies. Resonant DC Link Inverters with Zero Voltage Switching.	8
5	High Frequency Link Integral Half Cycle Converter	6
6	Modelling and design of DC-DC Converters for various renewable energy Conversion Few power electronic circuits used in practice for controlling electric drives.	8

Suggested reading

- Rashid "Power Electronics" Prentice Hall India 2007.
- G.K.Dubey et.al "Thyristorised Power Controllers" Wiley Eastern Ltd., 2005, 06.
- Dewan&Straughen "Power Semiconductor Circuits" John Wiley &Sons., 1975.
- G.K. Dubey& C.R. Kasaravada "Power Electronics & Drives" Tata McGraw Hill., 1993
- Cyril W Lander "Power Electronics" McGraw Hill., 2005.
- B. K Bose "Modern Power Electronics and AC Drives" Pearson Education (Asia)., 2007
- Abraham I Pressman "Switching Power Supply Design" McGraw Hill Publishing Company., 2001.

Course Outcomes:

Students will be able to:

- Knowledge about analysis and design of Load Commutated CSI and PWM CSI
- Learn analysis and design of series Inverters.
- Acquire knowledge about analysis and design of Switched Mode Rectifiers,APFC, DC-DC converters &Resonant converters

PE 1: OPTIMAL AND ADAPTIVE CONTROL (MPDT112)

Course Objectives:

Students will be able to:

- To know the operation of closed and open loop optimal control.
- Understand the adaptive control strategies.
- Learn dynamic programming method.

Units	Content	Hours
1	Optimal control problem – fundamental concepts and theorems of calculus Optimal control problem – fundamental concepts and theorems of calculus	5

2	.Variational approach to solving optimal control problems. Hamiltonian and different boundary conditions for optimal control problem.	8
3	Linear regulator problem - Pontryagin's minimum principle.	6
4	Dynamic programming – Principle of optimality and its application to optimal control problem	6
5	Hamilton-Jacobi-Bellman equation – model reference adaptive system (MRAS) - Design hypothesis	8
6	Introduction to design method based on the use of Liapunov function. Design and simulation of variable structure adaptive model following control.	8

Suggested reading

- Donald E. Kirk, "Optimal Control Theory, An introduction", Prentice Hall Inc., 2004
- A.P. Sage, "Optimum Systems Control", Prentice Hall, 1977
- HSU and Meyer , "Modern Control, Principles and Applications", McGraw Hill, 1968
- Yoan D. Landu, "Adaptive Control (Model Reference Approach)", Marcel Dekker. 1981
- K.K.D.Young, "Design of Variable Structure Model Following Control Systems", IEEE Transactions on Automatic Control, Vol. 23, pp 1079-1085, 1978.

Course Outcomes:

Students will be able to:

- Knowledge in the mathematical area of calculus of variation so as to apply the same for solving optimal control problems.
- Problem formulation, performance measure and mathematical treatment of optimal control problems.
- Acquire knowledge on solving optimal control design problems by taking into consideration the physical constraints on practical control systems.
- To obtain optimal solutions to controller design problems taking into consideration the limitation on control energy in the real practical world.

PE 1: POWER QUALITY(MPDT113)

Course Objective

Students will be able to:

- Understand the different power quality issues to be addressed
- Understand the recommended practices by various standard bodies like IEEE, IEC,etc.on voltage & frequency, harmonics
- Understanding STATIC VAR Compensators

Units	Content	Hours
1	Introduction-power quality-voltage quality-overview of power Quality phenomena classification of power quality issues. Power quality measures and standards-THD-TIF-DIN-C-message weights. Flicker factor transient phenomena-occurrence of power quality problems Power acceptability curves-IEEE guides Standards and recommended practices.	8

2	Harmonics-individual and total harmonic distortion RMS value of Three phase power converters-arcing devices saturable devices a harmonic waveform Triplex harmonics. Important harmonic introducing devices.SMPS Harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.	8
3	Modeling of networks and components under non-sinusoidal conditions Transmission and distribution systems Shunt capacitors-transformers.Electric machines. Ground systems loads that cause power quality problems. Power quality problems created by drives and its impact on drive.	6
4	Power factor improvement- Passive Compensation. Passive Filtering.HarmonicResonance.Impedance Scan Analysis Active Power Factor Corrected Single Phase Front End Control Methods for Single Phase APFC. Three Phase APFC and Control Techniques PFC based on Bilateral Single Phase and Three Phase Converter.	6
5	Hamilton-Jacobi-Bellman equation– model reference adaptive system (MRAS) - Design hypothesis	6
6	Introduction to design method based on the use of Liapunov function. Design and simulation of variable structure adaptive model following control.	8

Suggested Readings

- G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007
- Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000
- J. Arrillaga, "Power System Quality Assessment", John wiley, 2000
- J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,"Power system Harmonic Analysis", Wiley, 1997

Course Outcomes:

Students will be able to:

- Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonicson system equipment and loads
- develop analytical modeling skills needed for modeling and analysis of harmonics innetworks and components
- To introduce the student to active power factor correction based on static VAR compensators andits control techniques
- To introduce the student to series and shunt active power filtering techniques for harmonics.

PE 1: DYNAMICS OF ELECTRICAL MACHINES (MPDT 114)

Course Objective

Students will be able to:

- Learn Performance characteristics of machine.
- To understand the dynamics of the machine.
- To understand how to determine stability of machine.
  Learn the synchronous machine analysis

SYLLABUS

Units	Content	Hours
1	Stability. Primitive 4 Winding CommutatorMachine.Commutator Primitive Machine. Complete Voltage Equation of Primitive 4 Winding Commutator Machine.	8
2	Torque Equation. Analysis of Simple DC Machines using the Primitive Machine Equations . The Three Phase Induction Motor.Transformed Equations. Different Reference Frames for Induction Motor Analysis Transfer Function Formulation.	6
3	Three Phase Salient Pole Synchronous Machine. Parks Transformation- Steady State Analysis.	8
4	Large Signal Transient. Small Oscillation Equations in State Variable Form. Dynamical Analysis of Interconnected Machines.	6
5	Large Signal Transient Analysis using Transformed Equations. DC Generator /DC Motor System.	8
6	Alternator /Synchronous Motor System.	5

Suggested reading

- D.P. Sengupta& J.B. Lynn," Electrical Machine Dynamics", The Macmillan Press Ltd. 1980
- R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001
- P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company, 1987
- I. Boldia& S.A. Nasar,,"Electrical Machine Dynamics", The Macmillan Press Ltd. 1992
- C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967

Course Outcomes

Students will be able to:

- Formulation of electrodynamic equations of all electric machines and analyze the performance characteristics
- Knowledge of transformations for the dynamic analysis of machines
- Knowledge of determination of stability of the machines under small signal and transient conditions
- Study about synchronous machine

PE 2 STATIC VAR CONTROLLER AND HARMONIC FILTERING (MPDT121)

Course objective

Students will be able to:

- Understand the various static converters
- Understand the static converter control strategies
- Understand the active and reactive power compensation and their control
  Understand harmonic filtering and its control design

Syllabus

Units	Content	Hours
1	Fundamentals of Load Compensation. Steady-State Reactive Power Control in Electric Transmission Systems. Reactive Power Compensation and Dynamic Performance of Transmission Systems	6
2	Power Quality Issues: Sags, Swells, Unbalance, Flicker, Distortion. Current Harmonics.Sources of Harmonics in Distribution Systems and Ill Effects.	6
3	Static Reactive Power Compensators and their control.Shunt Compensators. SVCs of Thyristor Switched and Thyristor Controlled types and their control,STATCOMs and their control, Series Compensators of thyristor Switched and Controlled Type and their Control.SSSC and its Control, Sub-Synchronous Resonance and damping.Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power System.	10
4	Converters for Static Compensation. Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM).	8
5	Large Signal Transient Analysis using Transformed Equations. DC Generator /DC Motor System.	8
6	Alternator /Synchronous Motor System.	4

Suggested reading

- Ned Mohan et.al, "Power Electronics",John Wiley and Sons,2006.
- G. Massobrio, P. Antognet," Semiconductor Device Modeling with Spice", McGraw-Hill, Inc.,1988.
- B. J. Baliga," Power Semiconductor Devices",Thomson, 2004
- V. Benda, J. Gowar, D. A. Grant," Power Semiconductor Devices. Theory and Applications",JohnWiley& Sons1994.

Course Outcomes

Students will be able to:

- Acquire knowledge about the fundamental principles of Passive and Active Reactive PowerCompensation Schemes at Transmission and Distribution level in Power Systems.

- To introduce the student to various single phase and three-phase Static VAR Compensationschemes and their controls

To develop analytical modeling skills needed for modeling and analysis of such Static VAR

PE 2: PWM CONVERTERS AND APPLICATION (MPDT 122)

Course Objective

Students will be able to:

- Understand the concepts and basic operation of PWM converters, including basic circuit operation and design.
- Understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.

Syllabus

Units	Content	Hours
1	AC/DC and DC/AC power conversion. Overview of applications of voltage source converters and current source converters.	6
2	Pulse width modulation techniques for bridge converters Bus clamping PWM.Space vector based PWM. Advanced PWM techniques.	6
3	Practical devices in converter. Calculation of switching and conduction power losses.	4
4	Compensation for dead time and DC voltage regulation. Dynamic model of PWM converter. Multilevel converters. Constant V/F induction motor drives.	8
5	Estimation of current ripple and torque ripple in inverter fed drives. Line-side converters with power factor compensation.	8
6	Active power filtering.Reactive power compensation. Harmonic current compensation. Selective harmonic elimination PWM technique for high power electric drives.	8

Suggested reading

- Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John's Wiley and Sons.
- Erickson RW, "Fundamentals of Power Electronics", Chapman and Hall.

Vithyathil. J, "Power Electronics: Principles and Applications", McGraw Hill

Course Outcomes:

Students will be able to:

- Knowledge concepts and basic operation of PWM converters, including basic circuit operation and design
- Learn the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality
- Able to recognize and use the following concepts and ideas:Steady-State and transient modelling and analysis of power converters with various PWM techniques.

PE 2:POWER SEMICONDUCTOR DEVICES AND MODELING(MPDT 123)

Course Objectives:

Students will be able to:

- Understand the concepts and basic operation of PWM converters, including basic circuit operation and design
- Understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality

Syllabus

Units	Content	Hours
1	Energy auditing: Types and objectives. Audit instruments- ECO assessment and Economic methods specific energy analysis. Minimum energy paths-consumption models-Case study.	6
2	Electric Motors-Energy efficient controls and starting Efficiency. Motor Efficiency and Load Analysis. Energy efficient /high efficient Motors-Case study. Load Matching and selection of motors. Variable speed drives. Pumps and Fans-Efficient Control strategies. Optimal selection and sizing.Optimal operation and Storage: Case Study.	8
3	Transformer Loading/Efficiency analysis. Feeder/cable loss evaluation: Case study.Reactive PowerManagement. Capacitor Sizing-Degree of compensation. Capacitor losses-Location-Placement Maintenance, Case study.	8
4	Peak Demand controls- Methodologies. Types of Industrial loads-Optimal Load Scheduling-case study. Lighting- Energy efficient light sources. Energy conservation in Lighting Schemes. Electronic ballast-Power quality issues. Uminaries: case study	6
5	Cogeneration-types and Schemes. Optimal operation of cogeneration plants-case study Electric loads of Air conditioning & Refrigeration. Energy conservation measures. Cool storage. Types-optimal operation case study.	8
6	Electric water heating, Gysers, Solar Water Heaters. Power Consumption in Compressors. Energy conservation measures. Electrolytic Process. Computer Controls. Software-EMS.	8

Suggested reading

- Giovanni Petrecca,. "Industrial Energy Management: Principles and Applications", TheKluwer international series -207,1999
- Anthony J. Pansini, Kenneth D. Smalling,. "Guide to Electric Load Management", Pennwell Pub;(1998)
- Handbook on Energy Audit and Environment Management , Y P Abbi and Shashank Jain, TERI, 2006

- Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009.

Course Outcomes:

Students will be able to:

- Acquire the background required for engineers to meet the role of energy managers and toacquire the skills and techniques required to implement energy management.
- Identify and quantify the energy intensive business activities in an organization.
- Knowledge about standard methodologies for measuring energy in the workplace and energy audit instruments.
- Knowledge about energy efficient motors, load matching and selection of motors.
- Acquire knowledge about reactive power management, capacitor sizing and degree of compensation.

LAB 1- ELECTRICAL DRIVES LABORATORY

(MPDP001)

List of experiments:

- Study of Thyristor controlled D.C Drive.
- Study of Chopper Fed DC Motor.
- Study of A.C single phase motor speed control using TRIAC.
- PWM inverter fed three phase induction motor control using PSPICE/MATLAB/PSIM software.
- VSI/CSI fed induction motor drive analysis using MATLAB/PSPICE/PSIM software.
- Study of V/f control operation of three phase induction motor.
- Study of permanent magnet synchronous motor drive fed by PWM inverter using software.
- Regenerative/ Dynamic breaking operatation for DC motor study using software.
- Regenerative/ Dynamic breaking operatation for AC motor study using software.
- PC/PLC based AC/DC motor control operation.

LAB 2- ELECTRICAL MACHINES LABORATORY/POWER QUALITY LABORATORY(MPDP102/MPDP113)

Electrical machines lab

List of experiments:

- Load test on dc shunt motor to draw speed – torque and horse power – efficiency characteristics.
- Field Test on dc series machines.
- Speed control of dc shunt motor by armature and field control.
- Swinburne's Test on dc motor.
- Retardation test on dc shunt motor.
- Regenerative test on dc shunt machines.
- Load test on three phase induction motor.
- No load and Blocked rotor test on three phase induction motor
  (i)To draw equivalent circuit andcircle diagram. And
  (ii) Determination of performance parameters at different load conditions from
- Load test on induction generator.
- Load test on single phase induction motor to draw output versus torque, current, power and efficiency characteristics.
- Conduct suitable tests to draw the equivalent circuit of single phase induction motor and determine performance parameters.
- Conduct an experiment to draw V and curves of synchronous motor at no load and load

conditions.

Power Quality Lab

- To study the effect of non linear loads on power quality.
- To demonstrate the voltage and current distortions experimentally.
- To reduce the current harmonics with filters.
- To study the voltage sag due to starting of large induction motor.
- To study the capacitor switching transients.
- To study the effect of balanced non linear load on neutral current , in a three phase circuit
- To study the effect of ground loop.
- To study the effect of voltage flicker .
- To calculate the distortion power factor.
- Study the effect of harmonics on energy meter reading.
- To study effect of voltage sag on electrical equipments.
- To obtain the current harmonics drawn by power electronics interface using PSCAD software

Research Methodology and IPR

Teaching Scheme
Lectures: 1hrs/week

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

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics.
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Syllabus Content

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics ofa good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2: Effective literature studies approaches,

analysisPlagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patentinformation and databases.Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments inIPR; IPR of Biological Systems, Computer Software etc.Traditional knowledge Case Studies, IPR and IITs.

Refrences:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
- Mayall , "Industrial Design", McGraw Hill, 1992.
  Niebel , "Product Design", McGraw Hill, 1974.
- Asimov , "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

SEMESTER 2

CORE 3:POWER ELECTRONIC CONVERTERS (MPDT02)
Course Obejective :

- Understand the concepts and basic operation of PWM converters, including basic circuit operation and design.
- Understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality

Syllabus

Units	Contents	Hours

1	Analysis of power semiconductor switched circuits with R, L, RL, RC loads D.C. motor load. Battery charging circuit.	6
2	Single-Phase and Three-Phase AC to DC converters. Half controlled configurations-operating domains of three phase fullconverters and semi-converters. Reactive power considerations	8
3	Analysis and design of DC to DC converters. Control of DC-DC converters: Buck converters, Boost converters, Buck- Boost converters, Cuk converters.	6
4	Single phase and three phase inverters Voltage source and Current source inverters. Voltage control and harmonic minimization in inverters.	8
5	AC to AC power conversion using voltage regulators. Choppers and cyclo-converters. Consideration of harmonics, introduction to Matrix converters.	8
6	Design aspects of converters, Few practical applications.	8

Suggested reading

- Ned Mohan, Undeland and Robbin, "Power Electronics: converters, Application and design", John's Wiley and sons. Inc, Newyork.
- M.H.Rashid, "Power Electronics", Prentice Hall of India 1994.

Course Outcomes:
Students will be able to:

- To give a systematic approach for transient and steady state analysis of all power electronic converters with passive and active loads.
- To know and carry out transient and steady state analysis of different power converters of different types of loads and switching sequences.

CORE 4:DIGITAL CONTROL OF POWER ELECTRONICS AND DRIVESYSTEMS (MPDT202)

Course Objective:
Students will be able to:

- To understand different control strategies
- To understand state space modeling of different converters
- To perform simulation of different power converters

Syllabus

Units	Contents	Hours
1	Review of numerical methods. Application of numerical methods to solve transients in D.C. Switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits	6
2	Modelling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with AC supply. Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation. Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits.	8

3	State space modelling and simulation of linear systems. Introduction to electrical machine modelling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects.	6
4	Simulation of single phase and three phase uncontrolled and controlled(SCR) rectifiers. Converters with self-commutated devices- simulation of power factor correction schemes.	8
5	Simulation of converter fed DC motor drives. Simulation of thyristor choppers with voltage. Current and load commutation schemes. Simulation of chopper fed DC motor.	8
6	Simulation of single and three phase inverters with thyristors and self-commutated devices. Space vector representation. Pulse-width modulation methods for voltage control. Waveform control. Simulation of inverter fed induction motor drives.	8

Suggested reading

1. Simulink Reference Manual, Math works, USA

Course Outcomes

Students will be able to:

- To provide knowledge on modelling and simulation of power simulation circuits and systems.
- The candidate will be able to simulate power electronic systems and analyse the system response.

PE3: SWITCHED MODE AND RESONANT COVERTERS (MPDT 231)

Course Objectives:

Students will be able to:

1. To understand different types of converters
2. To understand different switch mode topologies & control methods
3. To understand different resonant converter topologies.

Syllabus

Units	Content	Hours
1	Buck, Boost, Buck-Boost SMPS Topologies. Basic Operation-Waveforms - modes of operation –switching stresses. Switching and conduction losses. Optimum switching frequency. Practical voltage, current and power limits - design relations. Voltage mode control principles. Push-Pull and Forward Converter Topologies - Basic Operation, Waveforms. Flux Imbalance Problem and Solutions	6

2	Transformer Design. Output Filter Design. Switching Stresses and Losses. Forward Converter Magnetics. Voltage Mode Control. Half and Full Bridge Converters. Basic Operation and Waveforms. Magnetics, Output Filter, Flux Imbalance, Switching Stresses and Losses, Power Limits, Voltage Mode Control.	8
3	Classification of Resonant Converters. Basic Resonant Circuit Concepts. Load Resonant Converter, Resonant Switch Converter, zero. Voltage Switching Clamped Voltage Topologies High Frequency Link Integral Half Cycle Converter. Fly back Converter- discontinuous mode operation, waveforms, control. Magnetics- Switching Stresses and Losses, Disadvantages - Continuous Mode Operation, waveforms, control, design relations.	6
4	Voltage Mode Control of SMPS- Loop Gain and Stability Considerations. Error Amp– frequency Response and Transfer Function. Trans-conductance Current Mode Control of SMPS. Current Mode Control Advantages, Current Mode Vs Voltage Mode.	8
5	Current Mode Deficiencies. Slope Compensation. Study of a typical Current Mode PWM Control IC UC3842. Modelling of SMPS Small Signal Approximation- General Second Order Linear Equivalent Circuits Study of popular PWM Control ICs (SG 3525, TL 494, MC 34060 etc.)	8
6	DC Transformer, Voltage Mode SMPS Transfer Function. General Control Law Consideration. EMI Generation and Filtering in SMPS - Conducted and Radiated Emission Mechanisms in SMPS. Techniques to reduce Emissions, Control of Switching Loci. Shielding and Grounding, Power Circuit Layout for minimum EMI. EMI Filtering at Input and Output, Effect of EMI Filter on SMPS Control Dynamics. Introduction to Resonant Converters.	8

Suggested reading

- Abraham I Pressman, "Switching Power Supply Design." McGraw Hill Publishing Company,2001.
- Daniel M Mitchell,"DC-DC Switching Regulator Analysis," McGraw Hill Publishing Company-1988.
- Ned Mohan et.al, "Power Electronics," John Wiley and Sons 2006.

Course Outcomes

- Acquire knowledge about the principles of operation of non-isolated and isolatedhard-switched DC-DC converters.
- Acquire knowledge on various loss components in a switched mode converter andchoice of switching frequency with a view towards design of such converters.

PE 3: INDUSTRIAL LOAD MODELING AND CONTROL (MPDT 232)

Course Objectives:

Students will be able to:

Students will be able to:

- To understand the energy demand scenario
- To understand the modelling of load and its ease to study load demand industrially
- To know Electricity pricing models
- Study Reactive power management in Industries

Syllabus

Units	Content	Hours
1	Electric Energy Scenario-Demand Side Management-Industrial Load Management. Load Curves-Load Shaping Objectives-Methodologies. Barriers; Classification of Industrial Loads- Continuous and Batch Processes -Load Modelling.	**6**
2	Electricity pricing – Dynamic and spot pricing –Models. Direct load control- Interruptible load control. Bottom up approach- scheduling- Formulation of loadmodels-Optimization and control algorithms - Case studies.	**8**
3	Reactive power management in industries-controls-power quality impacts Application of filters Energy saving in industries.	**6**
4	Cooling and heating loads- load profiling- Modelling. Cool storage-Types- Control strategies. Optimal operation-Problem formulation- Case studies.	**8**
5	Captive power units- Operating and control strategies- Power Pooling-Operation models. Energy banking-Industrial Cogeneration	**8**
6	Selection of Schemes Optimal Operating Strategies. Peak load saving-Constraints-Problem formulation- Case study. Integrated Load management for Industries	**8**

Suggested reading

- C.O. Bjork “Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989.
- C.W. Gellings and S.N. Talukdar, “Load management concepts,” IEEE Press, New York, 1986, pp. 3-28.
- Y. Manichaikul and F.C. Schweppe," Physically based Industrial load", IEEE Trans. on PAS, April 1981.
- H. G. Stoll, "Least cost Electricity Utility Planning”, Wiley Interscience Publication, USA, 1989.
- I.J.Nagarath and D.P.Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, New Delhi, 1995.
- IEEE Bronze Book- “Recommended Practice for Energy Conservation and cost effective planning Industrial facilities”, IEEE Inc, USA.

Course Outcomes:

Students will be able to:

- Knowledge about load control techniques in industries and its application.
- Different types of industrial processes and optimize the process using tools like LINDO and LINGO.
- Apply load management to reduce demand of electricity during peak time.

- Apply different energy saving opportunities in industries.

PE 3: ADVANCED DIGITAL SIGNAL PROCESSING (MPDT 233)

Students will be able to:

1. To understand the difference between discrete-time and continuous-time signals
2. 2. To understand and apply Discrete Fourier Transforms (DFT)

Syllabus

Units	Content	Hours
1	Discrete time signals Linear shift invariant systems- Stability and causality Sampling of continuous time signals- Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform Z transform-Properties of different transforms	**8**
2	Linear convolution using DFT Computation of DFT Design of IIR digital filters from analog filters Impulse invariance method Bilinear transformation method	**8**
3	FIR filter design using window functions Comparison of IIR and FIR digital filters Basic IIR and FIR filter realization structures Signal flow graph representations Quantization process and errors Coefficient quantization effects in IIR and FIR filters	**8**
4	A/D conversion noise- Arithmetic round-off errors Dynamic range scaling Overflow oscillations and zeroInput limit cycles in IIR filters Linear Signal Models	**8**
5	All pole, All zero and Pole-zero models Power spectrum estimation- Spectral analysis of deterministic signals. Estimation of power spectrum of stationary random signals	**8**
6	Optimum linear filters Optimum signal estimation Mean square error estimation Optimum FIR and IIR Filters	**6**

Suggested reading

- Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",TataMc Grow-Hill Edition 1998
- Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions .-2000

Course Outcomes:

Students will be able to:

- Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems

- Study the design techniques for IIR and FIR filters and their realization structures.
- Acquire knowledge about the finite word length effects in implementation of digital filters.
- Knowledge about the various linear signal models and estimation of power spectrum of stationary random signals
- Design of optimum FIR and IIR filters

PE 4: ADVANCED MICRO-CONTROLLER BASED SYSTEMS (MPDT 241)

Course objectives:
Students will be able to:

- To understand the architecture of advance microcontrollers
- To understand the applications of these controllers
- To get some introduction to FPGA

Syllabus

Units	Content	Hours
1	Basic Computer Organization Accumulator based processes-Architecture-Memory Organization-I/O Organization	**6**
2	Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories. I/O Ports, Serial Communication. Timers, Interrupts, Programming.	**8**
3	Intel 8051 – Assembly language programming-Addressing-Operations-Stack &Subroutines,Interrupts-DMA.	**6**
4	PIC 16F877- Architecture Programming. Interfacing Memory/ I/O Devices, Serial I/Oand data communication	**8**
5	Digital Signal Processor (DSP)- Architecture –Programming,Introduction to FPGA	**8**
6	Microcontroller development for motor control applications. Stepper motor control using micro controller.	**8**

Suggested reading

- John.F.Wakerly: "Microcomputer Architecture and Programming", John Wiley and Sons 1981.
- Ramesh S.Gaonker: "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishing (India), 1994.
- Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005.
- Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004.
- John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005.
- Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008.
- Microchip datasheets for PIC16F877.

Course Outcomes

Students will be able to:

- To learn how to program a processor in assembly language and develop an advanced processor based system
- To learn configuring and using different peripherals in a digital system
- To compile and debug a Program
- To generate an executable file and use it

PE 4:DISTRIBUTED GENERATION (MPDT242)

Course Objectives:
Students will be able to:

- To understand renewable energy sources.
- To gain understanding of the working of off-grid and grid-connected renewable energy generation schemes.

Syllabus

Units	Content	Hours
1	Need for Distributed generation. Renewable sources in distributed generation and current scenario inDistributed Generation.	**6**
2	Planning of DGs. Sitting and sizing of DGs optimal placement of DG sources indistribution systems. Grid integration of DGs Different types of interfaces, Inverter based DGsand rotating machine based interfaces. Aggregation of multiple DG units.	**8**
3	Technical impacts of DGs. Transmission systems Distribution Systems De-regulation Impact of DGsupon protective relaying. Impact of DGs upon transient and dynamic stability of existing distribution systems, Steady-state and Dynamic analysis.	**6**
4	Economic and control aspects of DGs Market facts. Issues and challenges Limitations of DGs, Voltage control techniques. Reactive power control, Harmonics Power quality issues, Reliability of DG based systems.	**8**
5	Introduction to micro-grids. Types of micro-grids: autonomous and non-autonomous grids Sizing of micro grids Modelling& analysis of Micro-grids with multiple DGs. Micro-grids with power electronic interfacing units.	**8**
6	Transients in micro-grids, Protection of micro-grids, case studies advanced topics.	**8**

Suggested reading

- H. Lee Willis, Walter G. Scott, “Distributed Power Generation – Planning and Evaluation”, Marcel Decker Press.
- M.GodoySimoes, Felix A.Farret, “Renewable Energy Systems – Design and Analysis with Induction Generators”, CRC press.
- Stuart Borlase. “Smart Grid: Infrastructure Technology Solutions” CRC Press

Course outcomes

Students will be able to:

- To understand the planning and operational issues related to Distributed Generation.
- Acquire Knowledge about Distributed Generation Learn Micro-Grids

PE 4: SMART GRIDS (MPDT 243)

Course Objectives:
Students will be able to:

- Understand concept of smart grid and its advantages over conventional grid.
- Know smart metering techniques.
- Learn wide area measurement techniques.
- Understanding the problems associated with integration of distributed generation & its solution through smart grid.

Syllabus

Units	Content	Hours
1	Introduction to Smart Grid, Evolution of Electric Grid. Concept of Smart Grid, Definitions, Need of Smart Grid. Concept of Robust &Self-Healing Grid, Present development &International policies in Smart Grid	**6**
2	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, Smart Substations, Substation Automation,Feeder Automation	**8**
3	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).	**6**
4	Concept of micro-grid, need & applications of micro-grid. Formation of micro-grid, Issues of interconnection. Protection & control of micro-grid. Plastic & Organic solar cells, Thin film solar cells. Variable speed wind generators, fuel-cells, micro-turbines. Captive power plants, Integration of renewable energy sources.	**8**
5	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, Power Quality Audit	**8**
6	Advanced Metering Infrastructure (AMI), Home Area Network (HAN). Neighbourhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication. Wireless Mesh Network Basics of CLOUD Computing &Cyber Security For Smart Grid. Broadband over Power line (BPL). IP based protocols	**8**

Suggested reading

- Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE,2011.
- Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press, 2009.
- JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications", Wiley 2012.
- Stuart Borlas'e, "Smart Grid:Infrastructure, Technology and solutions "CRC Press.
- A.G.Phadke "Synchronized Phasor Measurement and their Applications",Springer.

Course Outcomes

Students will be able to:

- Appreciate the difference between smart grid & conventional grid.
- Apply smart metering concepts to industrial and commercial installations.
- Formulate solutions in the areas of smart substations, distributed generation and wide area measurements.
- Come up with smart grid solutions using modern communication technologies

LAB 3- POWER ELECTRONICS LABORATORY

- To study V-I characteristics of SCR and measure latching and holding currents.
- To study UJT trigger circuit for half wave and full wave control.
- To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
- To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive and inductive loads.
- To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
- To study single-phase ac voltage regulator with resistive and inductiveloads.
- To study single phase cyclo-converter.
- To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor.
- To study operation of IGBT/MOSFET chopper circuit.
- To study MOSFET/IGBT based single-phase series-resonant inverter.
- To study MOSFET/IGBT based single-phase bridge inverter.

LAB 4–MICROCONTROLLER LAB/DIGITAL SIGNAL PROCESSING

LAB Microcontroller Lab

EXPERIMENTS ON ASSEMBLY PROGRAMMING

- Write a program to multiplication and division using MUL and DIV instructions.
- Write a program to transfer a block of data from internal memory to external memory.
- Write a program to exchange two set of eight-byte data.
- Write a program to find the sum of two numbers in decimal.
- Write a program to convert decimal number to hexadecimal.
- Write a program to add a number n, m number of times.
- Write program to find the largest from a set of n numbers.
- Write program for sorting the given set of numbers.

EXPERIMENTS ON 8051 INTERFACING

- Write an assembly language program for generating a triangular wave.
- Write a program to find the largest from a set of ten numbers and display it usingLEDs.
- Write a program to for displaying the decimal numbers in 7 Segment display.
- Write a program to read the DIP switches for displaying the reading using 7 Segmentdisplay.
- Write a program to rotate the given motor in clockwise direction.
- Write a program to rotate the given motor in anticlockwise direction.
- Write a program to generate a square wave.
- Write a program to display a message in LCD display.

Digital Signal Processing Lab

1.Introduction to Code Composer Studio-I
2.Introduction to Code Composer Studio-II
3.Introduction to the Addressing Modes

- FFT and Bit Reversal Operation
- FFT and its Applications
- Audio Codec and its Applications

- Real Time Data Exchange
- IR filtering by interfacing MATLAB with Code Composer Studio
- Introduction to Interrupts
- Digital communication using Binary Phase Shift Keying

SEMESTER -3

PE 5:SCADA SYSTEM AND APPLICATIONS(MPDT351)

Course Objective:
Students will be able to:

- To understand what is meant by SCADA and its functions.
- To know SCADA communication.
- To get an insight into its application.

Syllabus

Units	Content	Hours
1	Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies.	**6**
2	Monitoring and supervisory functions, SCADA applications in Utility Automation Industries SCADA	**8**
3	Industries SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems	**6**
4	SCADA Architecture: Various SCADA architectures, advantages anddisadvantages of each system - single unified standard architecture –IEC 61850.	**6**
5	SCADA Communication: various industrial communication technologies -wired and wireless methods and fibre optics, open standardcommunication protocols.	**6**
6	SCADA Applications: Utility applications- Transmission andDistribution sector- operations, monitoring, analysis and improvement. Industries - oil, gas And water Case studies, implementation, simulation exercises	**8**

Suggested reading

- Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of AmericaPublications, USA,2004.
- Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and RelatedSystems", Newnes Publications, Oxford, UK,2004.
- William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 2006.
- David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
- Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power",PennWell 1999.

Course Outcomes

- Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typicalapplications**.**
- Acquire knowledge about SCADA architecture, various advantages and disadvantages of eachsystem.
- Knowledge about single unified standard architecture IEC 61850.
- To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server.
- Learn and understand about SCADA applications in transmission and distribution sector, industries etc.

PE 5: FACTS AND CUSTOM POWER DEVICES (MPDT352)

Course Objectives:
Students will be able to:
- To learn the active and reactive power flow control in power system
- To understand the need for static compensators
- To develop the different control strategies used for compensation

Syllabus

Units	Content	Hours
1	Reactive power flow control in Power Systems – Control of dynamicpower unbalances in Power System. Power flow control -Constraints of maximum transmission line loading – Benefits of FACTS Transmission line compensation. Uncompensated line -Shunt compensation - Series compensation –Phase Angle control. Reactive power compensation. Shunt andSeries compensation principles – Reactive compensation attransmission and distribution level.	**6**
2	Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM - Operation and control of TSC, TCR and STATCOM – Compensator control. Comparison between SVC and STATCOM.	**8**
3	Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators – TCVR and TCPAR Operation and Control –Applications, Static series compensation – GCSC,TSSC, TCSC and Static synchronousseries compensators and their Control.	**6**
4	SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPF. Basic Principle of P and Q control- Independent real and reactive power flow control- Applications.	**6**
5	Introduction to interline power flow controller. Modelling and analysis of FACTS Controllers – Simulation of FACTS controllers Power quality problems in distribution systems, harmonics. Loads that create harmonics, modelling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering –shunt, series and hybrid and their control.	**6**
6	Voltage swells, sags, flicker, unbalance and mitigation of these problems By power line conditioners- IEEE standards on power quality.	6

Suggested reading

- K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New AgeInternationalPublishers, 2007**.**

- X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control",SpringerVerlag, Berlin, 2006.
- N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
- K.S.Sureshkumar, S.Ashok, "FACTS Controllers & Applications", E-book edition, Nalanda Digital Library, NIT Calicut, 2003.
- G. T.Heydt, "Power Quality", McGraw-Hill Professional, 2007.
- T. J. E. Miller, "Static Reactive Power Compensation", John Wiley and Sons, New York, 1982.

Course Outcomes:
Students will be able to:

- Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems.
- Learn various Static VAR Compensation Schemes like Thyristor/GTO Controlled.
- Reactive Power Systems, PWM Inverter based Reactive Power Systems and their controls.
- To develop analytical modelling skills needed for modelling and analysis of such Static VARSystems.

PE5: HVDC

Course Objectives:
Students will be able to:

- Understand state of the art HVDC technology.
- Learn the Methods to carry out modelling and analysis of HVDC system frontier-area power flow regulation.

Syllabus

Units	Content	Hours
1	Development of HVDC Technology, DC versus AC Transmission,Selection of converter configuration.	**6**
2	Rectifier and Inverter operation, Digital Simulation of converters, Control of HVDC converters and Systems.	**8**
3	Individual phase control, Equidistant firing controls, Higher level controls. Characteristics and non-characteristics harmonics filter design. Fault development and protection.	**6**
4	Interaction between AC-DC power systems. Over voltages on AC/DCside, multi-terminal HVDC systems, control of MTDC systems.	**6**
5	Modelling of HVDC systems, per unit system, Representation for power flow solution, representation for stability studies.	**6**
6	Introduction to relevant national and international standards, safe clearances for HV, Study regulations for HV tests, Digital techniques in HV measurements.	**6**

Suggested reading

- J. Arrillaga, "High Voltage Direct Transmission", Peter Peregrinus Ltd. London, 1983.
- K. R. Padiyar, "HVDC Power Transmission Systems", Wiley Eastern Ltd., 1990.
- E. W. Kimbark, "Direct Current Transmission", Vol. I, Wiley Interscience, 1971.
- Erich Uhlmann, "Power Transmission by Direct Current", B.S. Publications, 2004.

Course Outcomes:

Students will be able to:

- To expose the students to the state of the art HVDC technology.
- Knowledge of modelling and analysis of HVDC system for inter-area power flow regulation.
- Study of Neetishatakam will help in developing.

OPEN ELECTIVES

Business Analytics

Teaching scheme

Lecture: - 3 h/week

Course Code	
Course Name	**Business Analytics**
Credits **Prerequisites**	

Total Number of Lectures: 48

Course objective
• Understand the role of business analytics within an organization. • Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization. • To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making. • To become familiar with processes needed to develop, report, and analyze business data.

- Use decision-making tools/Operations research techniques.
- Mange business process using analytical and management tools.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

LECTURE WITH BREAKUP	NO. OF LECTURES
Unit1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	9
Unit 2: Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	8
Unit 3: Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	9
Unit 4: Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.	10
Unit 5: Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	8
Unit 6: Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	4

COURSE OUTCOMES	

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

Reference:

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

OPEN ELECTIVES
Industrial Safety

Teaching scheme

Lecture: - 3 h/week

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

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

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

Unit-IV: Fault tracing: Fault tracing-concept and importance, decision treeconcept, need andapplications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

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

Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Reference:

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

OPEN ELECTIVES

Operations Research

Teaching Scheme

Lectures: 3 hrs/week

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

- Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
- Students should able to apply the concept of non-linear programming
- Students should able to carry out sensitivity analysis
- Student should able to model the real world problem and simulate it.

Syllabus Contents:

Unit 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Unit 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Unit 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Unit 4

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Unit 5

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

References:

- H.A. Taha, Operations Research, An Introduction, PHI, 2008
- H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

- J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
- Hitler Libermann Operations Research: McGraw Hill Pub. 2009
- Pannerselvam, Operations Research: Prentice Hall of India 2010
- Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Open Elective

Cost Management & Engineering Projects

Teaching scheme

Lecture: - 3 h/week

Introduction and Overview of the Strategic Cost Management Process

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

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

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems.Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets.Measurement of Divisional profitability pricing decisions including transfer pricing.

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

References:

- Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
- Charles T. Horngren and George Foster, Advanced Management Accounting
- Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
- Ashish K. Bhattacharya, Principles & Practices of CostAccounting A. H. Wheeler publisher
- N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Open Elective

Composite Materials

Teaching scheme

Lecture: - 3 h/week

UNIT–I: INTRODUCTION: Definition – Classification and characteristics of Composite materials.Advantages and application of composites.Functional requirements of reinforcement and matrix.Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT – II: REINFORCEMENTS: Preparation-layup, curing, properties and applications of glassfibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT – III: Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique,Cladding – Hot isostaticpressing.Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT–IV: Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds andprepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT – V: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximumstrain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TEXT BOOKS:

- Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
- Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

REFERENCES:

- Hand Book of Composite Materials-ed-Lubin.
- Composite Materials – K.K.Chawla.
- Composite Materials Science and Applications – Deborah D.L. Chung.
- Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Open Elective
Waste to Energy

Teaching scheme

Lecture: - 3 h/week

Unit-I: Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forestresidue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit-II: Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

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

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

Unit-V: Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technologyand status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

References:

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

AUDIT 1 and 2: ENGLISH FOR RESEARCH PAPER WRITING

Course objectives:

Students will be able to:

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title

Units	CONTENTS	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	4
6	useful phrases, how to ensure paper is as good as it could possibly be the	4

first- time submission		

Suggested Studies:

- Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
- Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
- Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
- Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

UDIT 1 and 2: DISASTER MANAGEMENT

Course Objectives:-Students will be able to:

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus

Units	CONTENTS	Hours
1	**Introduction** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	**Repercussions Of Disasters And Hazards**: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	**Disaster Prone Areas In India** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	**Disaster Preparedness And Management** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	**Risk Assessment** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4
6	**Disaster Mitigation**	4

	Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	

SUGGESTED READINGS:

- R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
- Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
- Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	***Content***	***Hours***
1	Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences	8
2	Order Introduction of roots Technical information about Sanskrit Literature	8
3	Technical concepts of Engineering-Electrical,Mechanical, Architecture, Mathematics	8

Suggested reading

- "Abhyaspustakam" – Dr.Vishwas, Sanskrit-BhartiPublication,New Delhi
- "Teach Yourself Sanskrit" PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
- "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

AUDIT 1 and 2: VALUE EDUCATION

Course Objectives

Students will be able to

1**.** Understand value of education and self- development

- Imbibe good values in students
- Let the should know about the importance of character

Syllabus

Unit	***Content***	***Hours***
1	Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements	4
2	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance.Confidence,Concentration.Truthfulness, Cleanliness. Honesty ,Humanity.Power of faith, National Unity. Patriotism.Love for nature ,Discipline	6
3	Personality and Behaviour Development - Soul and Scientific attitude.PositiveThinking.Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature	6
4	Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality ,Non violence ,Humility, Role of Women. All religions and same message. Mind your Mind ,Self-control. Honesty, Studying effectively	6

Suggested reading

1 Chakroborty , S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press ,New Delhi

Course outcomes

Students will be able to

1.Knowledge of self-development 2.Learn the importance of Human values

3.Developing the overall personality

AUDIT 1 and 2: CONSTITUTION OF INDIA

Course Objectives:

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus

Units	Content	Hours
	History of Making of the Indian Constitution:	
1	History Drafting Committee, (Composition& Working)	4
	Philosophy of the Indian Constitution:	
2	Preamble Salient Features	4
3	**Contours of Constitutional Rights & Duties:** Fundamental Rights Right to Equality Right to Freedom Right against Exploitation Right to Freedom of Religion Cultural and Educational Rights Right to Constitutional Remedies Directive Principles of State Policy Fundamental Duties.	4
4	**Organs of Governance:** Parliament Composition Qualifications and Disqualifications Powers and Functions Executive President Governor Council of Ministers	4

	Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions	
5	**Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	4
6	**Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	4

SuggestedReading

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

Course Outcomes:

Students will be able to:

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

AUDIT 1 and 2: PEDAGOGICAL STUDIES

Course Objectives:

Students will be able to:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Syllabus

Units	Content	Hours
1	**Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and Terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.	4

2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.	2
3	Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.	4
4	Professional development: alignment with classroom practices and follow-up support Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes	4
5	**Research gaps and future directions** Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.	2

Suggested reading

- Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
- Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
- Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
- Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
- Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
- Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
- www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to understand:

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

Course Objectives

- To achieve overall health of body and mind
- To overcome stress

Syllabus

Unit	***Content***	***Hours***
1	Definitions of Eight parts of yog. (Ashtanga)	8
2	Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	8
3	Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayam	8

Suggested reading

- 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami YogabhyasiMandal, Nagpur
- "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

Course Outcomes:

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE and ENLIGHTENMENT SKILLS

Course Objectives

- To learn to achieve the highest goal happily

  To become a person with stable mind, pleasing personality and determination

  To awaken wisdom in students

Syllabus

Unit	Content	Hours
1	Neetisatakam-Holistic development of personality Verses- 19,20,21,22 (wisdom) Verses- 29,31,32 (pride & heroism) Verses- 26,28,63,65 (virtue) Verses- 52,53,59 (dont's) Verses- 71,73,75,78 (do's)	8
2	Approach to day to day work and duties. ShrimadBhagwadGeeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.	8
3	Statements of basic knowledge. ShrimadBhagwadGeeta : Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 Personality of Role model. ShrimadBhagwadGeeta : Chapter2-Verses 17,Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63	8

Suggested reading

- "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata

- Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.