UTTARAKHAND TECHNICAL UNIVERSITY,
DEHRADUN

M TECH (Power Electronics and Drives)
Programme
2018
### Semester 1

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Core/El. Code</th>
<th>Course name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Core 1 (MPDT101)</td>
<td>Electric Drives System</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Core2 (MPDT102)</td>
<td>Modeling and Analysis of Electrical Machines</td>
<td>3</td>
</tr>
</tbody>
</table>
| 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       |
| 4       | PE 2 (MPDT121)  (MPDT122) (MPDT123) | 1.Static VAR Controllers and Harmonic Filtering  
2.PWM converter and Applications  
3.Power Semiconductor Devices &Modelling | 3       |
| 5       | (MOET191) | Research Methodology and IPR                     | 2       |
| 6       | Lab 1 (MPDP101) | Electrical Drives Laboratory                     | 0       |
| 7       | Lab 2 (MPDP102) (MPDP113) | 1.Electrical Machines Laboratory  
2.Power Quality lab | 0       |
| 8       | Audit -I (MAUT191) | Audit I                                         | 2       |
|         | Total Credits |                                           | 18      |

### Semester 2

<table>
<thead>
<tr>
<th>Sr. No.</th>
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<th>Course name</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>Core 3 (MPDT201)</td>
<td>Power Electronic Converters</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Core4 (MPDT202)</td>
<td>1.Digital Control of Power Electronic and Drive Systems</td>
<td>3</td>
</tr>
</tbody>
</table>
| 3       | PE3 (MPDT231)  (MPDT232) (MPDT233) | 1.Switched Mode and Resonant Converters  
2.Industrial Load Modeling and Control  
3.Advanced Digital Signal Processing | 3       |
| 4       | PE 4 (MPDT241)  (MPDT242) (MPDT243) | 1.Advanced Microcontroller based Systems  
2.Distributed Generation  
3.Smart Grids | 3       |
| 5       | (MPDP202) | Mini Project with seminar                        | 0       |
| 6       | Lab 3 (MPDP201) | Power Electronics Laboratory                     | 0       |
Lab 4 (MPDP241) 1. Micro-controller Lab 2. Digital Signal Processing Lab (based on core 4) 0 0 4 2
Audit -II (MAUT292) Audit II 2 0 0 0
Total Credits 18

**Semester 3**

<table>
<thead>
<tr>
<th>Sr. No.</th>
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<th>Course name</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>PE5 (MPDT351)</td>
<td>1. SCADA Systems and Applications 2. FACTS and Custom Power Devices 3. HVDC</td>
<td>3 0 0 3</td>
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<tr>
<td>5</td>
<td>Major Project</td>
<td>Phase- I Dissertation</td>
<td>0 0 20 10</td>
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<td>(MPDP301)</td>
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<td>Total Credits</td>
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**Semester 4**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Core/El. Code</th>
<th>Course name</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>Major Project</td>
<td>Phase- II Dissertation</td>
<td>0 0 32 16</td>
</tr>
<tr>
<td></td>
<td>(MPDP401)</td>
<td></td>
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<tr>
<td>Total Credits</td>
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<td></td>
<td>16</td>
</tr>
</tbody>
</table>

**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 circuits for specific application.

**PO3** Use modern tools, professional software platforms, embedded systems for the diversified applications.

**PO4** Explore ideas for inculcating research skills.

**PO5** Solve the problems which need critical and independent thinking to show reflective learning.
PO6 Imagine the larger picture and correlate the domain knowledge with the global industrial problems.

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

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


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

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Principles of Electromagnetic Energy Conversion.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>General expression of stored magnetic energy.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Co-energy and force/torque, example using single and doubly excited system</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>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.</td>
<td>8</td>
</tr>
</tbody>
</table>
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

Determination of Synchronous machine dynamic equivalent circuit parameters
Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine

Special Machines - Permanent magnet synchronous machine
Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines
Construction and operating principle

Dynamic modelling and selfcontrolled operation. Analysis of SwitchReluctance Motors.
Brushless D.C. Motor for space Applications Recent trends

Suggested reading
• Charles Kingsle,Jr., A.E. Fitzgerald, Stephen D.Umans, “Electric Machinery”, Tata Megraw Hill
• Miller, T.J.E., “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press

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.

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Boost type APFC and control.</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Three phase utility interphases and control-Buck, Boost, Buck-Boost SMPS Topologies, Modes of operation –Push-Pull and Forward Converter Topologies - Voltage Mode Control.</td>
<td>6</td>
</tr>
</tbody>
</table>

High Frequency Link Integral Half Cycle Converter

Modelling and design of DC-DC Converters for various renewable energy Conversion Few power electronic circuits used in practice for controlling electric drives.

Suggested reading

- B. K Bose “Modern Power Electronics and AC Drives” Pearson Education (Asia), 2007

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.

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Optimal control problem – fundamental concepts and theorems of calculus</td>
<td>5</td>
</tr>
</tbody>
</table>
Variational approach to solving optimal control problems. Hamiltonian and different boundary conditions for optimal control problem.

Linear regulator problem - Pontryagin’s minimum principle.

Dynamic programming – Principle of optimality and its application to optimal control problem.

Hamilton-Jacobi-Bellman equation – model reference adaptive system (MRAS) - Design hypothesis.

Introduction to design method based on the use of Liapunov function. Design and simulation of variable structure adaptive model following control.

Suggested reading


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

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
</table>
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.

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.

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.

Hamilton-Jacobi-Bellman equation—model reference adaptive system
(MRAS) - Design hypothesis

Introduction to design method based on the use of
Liapunov function.
Design and simulation of variable structure adaptive model
following control.

Suggested Readings

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
and its 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

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Three Phase Salient Pole Synchronous Machine. Parks Transformation-Sliding State Analysis.</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Large Signal Transient. Small Oscillation Equations in State Variable Form. Dynamical Analysis of Interconnected Machines.</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Large Signal Transient Analysis using Transformed Equations. DC Generator/DC Motor System.</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Alternator/Synchronous Motor System.</td>
<td>5</td>
</tr>
</tbody>
</table>

### Suggested reading


### 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

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**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**

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Power Quality Issues: Sags, Swells, Unbalance, Flicker, Distortion. Current Harmonics. Sources of Harmonics in Distribution Systems and Ill Effects.</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>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.</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Converters for Static Compensation. Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM).</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Large Signal Transient Analysis using Transformed Equations. DC Generator/DC Motor System.</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Alternator/Synchronous Motor System.</td>
<td>4</td>
</tr>
</tbody>
</table>

**Suggested reading**


**Course Outcomes**

Students will be able to:
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

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

Suggested reading


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

<table>
<thead>
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<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Energy auditing: Types and objectives. Audit instruments- ECO assessment and Economic methods specific energy analysis. Minimum energy paths-consumption models-CASE study.</td>
<td>6</td>
</tr>
</tbody>
</table>

### Suggested reading

Course Outcomes:

Students will be able to:
- Acquire the background required for engineers to meet the role of energy managers and to acquire 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 operation for DC motor study using software.
- Regenerative/ Dynamic breaking operation 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 and circle 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 of a 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, analysis, Plagiarism, 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


References:
- Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”
- Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

SEMESTER 2

CORE 3: POWER ELECTRONIC CONVERTERS (MPDT02)
Course Objective:
- 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

<table>
<thead>
<tr>
<th>Syllabus</th>
<th>Units</th>
<th>Contents</th>
<th>Hours</th>
</tr>
</thead>
</table>

**Suggested reading**


**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**

<table>
<thead>
<tr>
<th>Units</th>
<th>Contents</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>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</td>
<td>6</td>
</tr>
</tbody>
</table>
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.

Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers. Converters with self-commutated devices - simulation of power factor correction schemes.


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 CONVERTERS (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

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>topics</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>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.</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>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.)</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>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.</td>
<td>8</td>
</tr>
</tbody>
</table>

Suggested reading

Course Outcomes
- Acquire knowledge about the principles of operation of non-isolated and isolated hard-switched DC-DC converters.
- Acquire knowledge on various loss components in a switched mode converter and choice 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:

- 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

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>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.</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Reactive power management in industries-controls-power quality impacts Application of filters Energy saving in industries.</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Cooling and heating loads- load profiling- Modelling. Cool storage-Types- Control strategies. Optimal operation-Problem formulation- Case studies.</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Captive power units- Operating and control strategies- Power Pooling-Operation models. Energy banking-Industrial Cogeneration</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Selection of Schemes Optimal Operating Strategies. Peak load saving-Constraints-Problem formulation- Case study. Integrated Load management for Industries</td>
<td>8</td>
</tr>
</tbody>
</table>

Suggested reading

- 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. To understand and apply Discrete Fourier Transforms (DFT)

Syllabus

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
</table>
| 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

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

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

Suggested reading

• 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

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Need for Distributed generation. Renewable sources in distributed generation and current scenario in Distributed Generation.</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>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.</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>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.</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Transients in micro-grids, Protection of micro-grids, case studies advanced topics.</td>
<td>8</td>
</tr>
</tbody>
</table>

Suggested reading
- 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

<table>
<thead>
<tr>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to Smart Grid, Evolution of Electric Grid. Concept of Smart Grid, Definitions, Need of Smart Grid. Concept of Robust &amp;Self-Healing Grid, Present development &amp;International policies in Smart Grid</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>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 &amp; Building Automation, Smart Substations, Substation Automation,Feeder Automation</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Power Quality &amp; 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</td>
<td>8</td>
</tr>
</tbody>
</table>
Suggested reading

- Stuart Borlas’e, “Smart Grid: Infrastructure, Technology and solutions” CRC Press.

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 inductive loads.
- 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 using LEDs.
- 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 Segment display.
- 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

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

Suggested reading


Course Outcomes
• Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.
• Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.
• 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

<table>
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<tr>
<th>Syllabus</th>
<th>Units</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>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.</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>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.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>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.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>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.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Voltage swells, sags, flicker, unbalance and mitigation of these problems By power line conditioners- IEEE standards on power quality.</td>
<td>6</td>
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</tr>
</tbody>
</table>

Suggested reading

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 VAR Systems.

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

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

Suggested reading

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Prerequisites</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Business Analytics</td>
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</table>

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.
- Manage 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.

<table>
<thead>
<tr>
<th>LECTURE WITH BREAKUP</th>
<th>NO. OF LECTURES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 1:</strong> 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.</td>
<td>9</td>
</tr>
<tr>
<td><strong>Unit 2:</strong> 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.</td>
<td>8</td>
</tr>
<tr>
<td><strong>Unit 3:</strong> 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.</td>
<td>9</td>
</tr>
<tr>
<td><strong>Unit 5:</strong> Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.</td>
<td>8</td>
</tr>
<tr>
<td><strong>Unit 6:</strong> Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.</td>
<td>4</td>
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</tbody>
</table>

**COURSE OUTCOMES**
Students will demonstrate knowledge of data analytics.
Students will demonstrate the ability to 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 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 electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety 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-IV: Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

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

**Reference:**

- Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.

**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 be able to apply the dynamic programming to solve problems of discrete and continuous variables.
- Students should be able to apply the concept of non-linear programming
- Students should be able to carry out sensitivity analysis
- Students should be 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:**

Open Elective
Cost Management & Engineering Projects

Teaching scheme

Lecture: - 3 h/week

Introduction and Overview of the Strategic Cost Management Process


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 technical activities. Detailed Engineering activities. Pre project execution main clearances and documents. Project team: Role of each member. Importance of 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.


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
- N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Open Elective
Composite Materials

Teaching scheme

Lecture: - 3 h/week


UNIT – V: Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain 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:

REFERENCES:

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, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors


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 technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - 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:

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

<table>
<thead>
<tr>
<th>Units</th>
<th>CONTENTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness</td>
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<td>3</td>
<td>Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.</td>
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<tr>
<td>4</td>
<td>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.</td>
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<td>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</td>
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<td>6</td>
<td>useful phrases, how to ensure paper is as good as it could possibly be the</td>
<td>4</td>
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</tbody>
</table>
first-time submission

Suggested Studies:
- Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.

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

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<thead>
<tr>
<th>Units</th>
<th>CONTENTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Introduction</strong>&lt;br&gt;Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.</td>
<td>4</td>
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<td>2</td>
<td><strong>Repercussions Of Disasters And Hazards:</strong> 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.</td>
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<td>3</td>
<td><strong>Disaster Prone Areas In India</strong>&lt;br&gt;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</td>
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<tr>
<td>4</td>
<td><strong>Disaster Preparedness And Management</strong>&lt;br&gt;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.</td>
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<td>5</td>
<td><strong>Risk Assessment</strong>&lt;br&gt;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.</td>
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<tr>
<td>6</td>
<td><strong>Disaster Mitigation</strong></td>
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</table>
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:

- Sahni, Pardeep Et. 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

<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
<th>Hours</th>
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<tbody>
<tr>
<td>1</td>
<td>Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences</td>
<td>8</td>
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<td>2</td>
<td>Order Introduction of roots Technical information about Sanskrit Literature</td>
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<tr>
<td>3</td>
<td>Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics</td>
<td>8</td>
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</tbody>
</table>

Suggested reading

- “Abhyaspustakam” – Dr. Vishwas, Sanskrit-BhartiPublication, New Delhi
- “Teach Yourself Sanskrit” PrathamaDeeksha-VempatiKutumbhashstri, 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

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<tr>
<th>Unit</th>
<th>Content</th>
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<tbody>
<tr>
<td>1</td>
<td>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</td>
<td>4</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>History of Making of the Indian Constitution:</td>
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<td>History</td>
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<td>Drafting Committee, (Composition &amp; Working)</td>
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<td>Philosophy of the Indian Constitution:</td>
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<td>Preamble</td>
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<td>Salient Features</td>
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<td>Contours of Constitutional Rights &amp; Duties:</td>
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<td>Fundamental Rights</td>
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<td>Right to Equality</td>
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<td>Right against Exploitation</td>
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<td>Right to Freedom of Religion</td>
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<td>Cultural and Educational Rights</td>
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<td>Right to Constitutional Remedies</td>
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<td>Directive Principles of State Policy</td>
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<td>Fundamental Duties.</td>
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<td>Organs of Governance:</td>
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<td>4</td>
<td>Parliament</td>
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<td>Qualifications and Disqualifications</td>
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<td>Powers and Functions</td>
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<td>Council of Ministers</td>
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</table>

**Suggested Reading**

- The Constitution of India, 1950 (Bare Act), Government Publication.

**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**

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>Introduction and Methodology:</td>
<td>Aims and rationale, Policy background, Conceptual framework and Terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.</td>
<td>4</td>
</tr>
</tbody>
</table>
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.

Curriculum, Teacher education.

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.

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

Research gaps and future directions
Research design
Contexts
Pedagogy
Teacher education
Curriculum and assessment
Dissemination and research impact.

Suggested reading


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

<table>
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<tr>
<th>Unit</th>
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<tbody>
<tr>
<td>1</td>
<td>Definitions of Eight parts of yog. ( Ashtanga )</td>
<td>8</td>
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<tr>
<td>2</td>
<td>Yam and Niyam. Do’s and Don’t’s in life. i) Ahinsa, satya, astheya, brahmacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpanidhan</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Asan and Pranayam i) Various yog poses and their benefits for mind &amp; body ii)Regularization of breathing techniques and its effects - Types of pranayam</td>
<td>8</td>
</tr>
</tbody>
</table>

Suggested reading

- ‘Yogic Asanas for Group Training-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**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Content</th>
<th>Hours</th>
</tr>
</thead>
</table>
| 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.