SCHEME & SYLLABI

OF

M.TECH.

ELECTRICAL & ELECTRONICS ENGINEERING

w.e.f.

2018 -2019

(as per AICTE Model Curriculum)

CH. BANSI LAL UNIVERSITY, BHIWANI

First Semester:

Subject Code	Subject Name	L-T-P	Credits	Mark Weightage		Course Type
				Internal	External	
18MEEE-501	Electric Drives System	3-0-0	3	25	75	Core-I
18MEEE-503	Power System Analysis	3-0-0	3	25	75	Core-II
	Discipline Specific Elective-1	3-0-0	3	25	75	Programme Elective I
	Discipline Specific Elective-2	3-0-0	3	25	75	Programme Elective II
18MEEE-505	Research Methodology and IPR	3-0-0	2	25	75	Core
18MEEE-507	Power System Analysis Lab	0-0-4	2	25	25	Core
18MEEE-509	Electrical Drives Laboratory	0-0-4	2	25	75	Core
	Audit Course-I	2-0-0	0	25	75	Audit
	Total	**17-0-8**	**18**	**200**	**500**	

Discipline Specific Elective-I

18MEEE-511 Advance Digital Processing
18MEEE-513 Process Control
18MEEE-515 Power Quality

Discipline Specific Elective-II
18MEEE-517 Advance Microcontroller Based System
18MEEE-519 Optimal Control Theory
18MEEE-521 Robotics and Automation

Audit course 1 & 2

18 AUD- 101 Research Paper Writing
18 AUD -102 Disaster Management
18 AUD -103 Sanskrit and Technology
18 AUD -104 Value Education
18 AUD -105 Constitution of India
18 AUD -106 Pedagogy Studies
18 AUD -107 Stress Management
18 AUD -108 Personality Development through Life Enlightenment Skills

Second Semester:

Subject Code	Subject Name	L-T-P	Credits	Mark Weightage		Course Type
				Internal	External	
18MEEE-502	Digital Protection of Power System	3-0-0	3	25	75	Core-III
18MEEE-504	Non-Conventional Electrical Energy Systems	3-0-0	3	25	75	Core-IV
	Discipline Specific Elective-III	3-0-0	3	25	75	Programme Elective III
	Discipline Specific Elective-IV	3-0-0	3	25	75	Programme Elective IV
18MEEE-506	Power System Protection Lab	0-0-4	2	25	25	Core
18MEEE-508	Non-Conventional Energy Sources lab	0-0-4	2	25	25	Core
	Audit Course- 2	2-0-0	0	25	75	Audit
18MEEE-510	Mini-Project	0-0-4	2	25	75	Core
	Total	**14-0-12**	**18**	**200**	**500**	

Discipline Specific Elective-III

18**MEEE-512 AI Techniques**
18MEEE-514 Smart Grid
18MEEE-516 High Voltage Engineering

Discipline Specific Elective-IV

18MEEE-518 Electrical Power Distribution System
18MEEE-520 Advance Control System
18MEEE-522 Wind & Solar Energy

Third Semester:

Subject Code	Subject Name	L-T-P	Credits	Mark Weightage		Course Type
				Internal	External	
	Discipline Specific Elective-V	3-0-0	3	25	75	Programme Elective V
	Open Elective	3-0-0	3	25	75	Open Elective
18MEEE-523	Dissertation Phase-I	0-0-20	10	50	150	Dissertation
	Total	**6-0-20**	**16**	**100**	**300**	

Discipline Specific Elective-V

18**MEEE-525 FACTS and Custom Power Devices**
18MEEE-527 PLC Controller and their Application
18MEEE-529 SCADA System and Applications

Open Elective

18 OEC- 531 Business Analytics
18 OEC -533 Industrial Safety
18 OEC -535 Operations Research
18 OEC -537 Cost Management of Engineering Projects
18 OEC -539 Composite Materials
18 OEC -541 Waste to Energy

Fourth Semester:

Subject Code	Subject Name	L-T-P	Credits	Mark Weightage		Course Type
				Internal	External	
18MEEE-524	Dissertation Phase-II	0-0-32	16	150	350	Dissertation
	Total	**0-0-32**	**16**	**150**	**350**	

Total Credits for the programme = 18 + 18 +16 +16 = 68 Credits

Course code	**18MEEE-501**
Course title	**ELECTRIC DRIVE SYSTEM**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

Students will be able to:

1. Understand Basic electrical drives and their analysis.
2. Learn Design of controller for drives.
3. Understand Scalar control of electrical drives.

Unit 1

Dynamics of Electric Drives: Fundamentals of torque equation, Speed torque convention and multi-quadrant operation, components of load torques.

Classification of load torques steady state stability, Load equation, Speed control and drive classification, close loop control of drives.

Unit 2

DC motor Drives: Modeling of DC machines, Steady state characteristics with armature and speed control, Phase controlled DC motor drives and chopper controlled DC motor drives.

Unit 3 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.

Unit 4 Traction motor: Starting, Speed-Time characteristics, Braking, traction motors used in practice.

Industrial Drives: Digital Control of Electric Drives, Stepper motor, Servo motor and their Applications.

Course Outcomes:

Students will be able to:

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

5. Implement various variable speed drives in Electrical Energy Conversion System

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 3rd edition.
6. K. Bose, “Modern Power Electronics and AC Drives”, Prentice Hall publication, 1st edition, 2001.

Course code	**18MEEE-503**
Course title	**POWER SYSTEM ANALYSIS**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives-

Students will be able to:

1. Study various methods of load flow and their advantages and disadvantages
2. Understand how to analyze various types of faults in power system
3. Understand power system security concepts and study the methods to rank the contingencies
4. Understand need of state estimation and study simple algorithms for state estimation
5. Study voltage instability phenomenon

Unit 1

Load flow: Overview of Newton-Raphson, Gauss-Siedel, fast decoupled methods, convergence properties, sparsity techniques, handling Qmax violations in constant matrix, inclusion in frequency effects, AVR in load flow, handling of discrete variable in load flow.

Unit 2

Fault Analysis: Simultaneous faults, open conductor's faults, generalized method of fault analysis.
Security Analysis: Security state diagram, contingency analysis, generator shift distribution factors, line outage distribution factor, multiple line outages, overload index ranking

Unit 3

Power System Equivalents: WARD, REI equivalents
State Estimation: Sources of errors in measurement, Virtual and Pseudo, Measurement, Observability, Tracking state estimation, WSL method, bad data correction.

Unit 4

Voltage Stability: Voltage collapse, P-V curve, multiple power flow solution, continuation power flow, optimal multiplies load flow, voltage collapse proximity indices.

Course outcomes-

Students will be able to:

1. Able to calculate voltage phasors at all buses, given the data using various methods of load flow
2. Able to calculate fault currents in each phase

3. Rank various contingencies according to their severity
4. Estimate the bus voltage phasors given various quantities viz. power flow, voltages, taps, CB status etc.
5. Estimate closeness to voltage collapse and calculate PV curves using continuation power flow

Suggested reading

1. J.J. Grainger &W.D. Stevenson, “Power system analysis”, McGraw Hill, 2003
1. A.R. Bergen & Vijay Vittal, “Power System Analysis”, Pearson, 2000
2. L.P. Singh, “Advanced Power System Analysis and Dynamics”, New Age International, 2006
3. G.L. Kusic, “Computer aided power system analysis”, Prentice Hall India, 1986
4. A.J. Wood, “Power generation, operation and control”, John Wiley, 1994
5. P.M. Anderson, “Faulted power system analysis”, IEEE Press, 1995

Course code	**18MEEE-505**
Course title	**RESEARCH METHODOLOGY AND IPR**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

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.

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 3

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 4

Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.

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

Course Outcomes:

1. At the end of this course, students will be able to:
2. Understand research problem formulation
3. Analyze research related information
4. Follow research ethics

5. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
6. 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.
7. 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.

References:

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

Course code	**18MEEE-511**
Course title	**ADVANCED DIGITAL SIGNAL PROCESSING**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:-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)

Unit 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

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear transformation method

Unit 2

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 quantisation effects in IIR and FIR filters

Unit 3

A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zeroInput limit cycles in IIR filters, Linear Signal Models

All pole, All zero and Pole-zero models, Power spectrum estimation, Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals

Unit 4

Optimum linear filters, Optimum signal estimation, Mean square error estimation,

Optimum FIR and IIR Filters

Course Outcomes:

Students will be able to:

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

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

Suggested reading

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

Course code	**18MEEE-513**
Course title	**PROCESS CONTROL**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Unit 1

Basic consideration : Introduction to process control system, control loop study, generalization with load changes at arbitrary points in the loop, offset and its analysis, modeling considerations for control purposes, degree of freedom and process controllers, formulating the scope of modeling for process control, computer simulation and linearization of non-linear system transfer functions and input output models

Unit 2

Designing feed back controller: Outline of the design problems, selection of type of feedback controller, time-integral performance criterion, process reaction curve and frequency response characteristic, Ziegler-Nichol Rule, effect of dead time, dead-time compensator and inverse response compensator.

Unit 3

Control Systems with multiple loops: Feed forward and cascade control system, Multivariable system & multivariable turning technique non-inferential and over ride control, Interaction & De-coupling of control loop: Interaction of control loops, relative gain array and selection of the loops, Design of non-interaction control loop.

Unit 4

Computer process interface for Data Acquisition and control: Introduction to digital, computer control process, optimal and adaptive control of processes, online tuning, process control languages and application packages, operating system for real-time Process control.

REFERENCE BOOKS:

1. Chemical Process Control –George Stephanopoulos –PHI Publications.
2. Digital Computer Process Control –C.L. Smith Pub : Intext Educational Publisher.
3. Process Control F.G. Shinkey, Pub. Mc-Graw Hill.
4. Advanced Process Control-W.H. Ray, Pub. Mc Graw-Hill.
5. Process system and analysis and control –D.R. Coushanour, TMH.

6. Prokeess Instrument & Control handbook –D.M. Considins, Pub: Mc-Graw Hill.
7. Chemical Process Control CPC –M. Morari and T.J. McAvoy. CACHE/Elsevier, Amsterdam, 1986 F.G.
8. Handbook of Advance Process Control & Instrumentation Systems-Les Kane, -Gulf Publishing Company, Huston, Texas.

Course code	**18MEEE-515**
Course title	**POWER QUALITY**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives: -

Students will be able to:

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

Unit 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-I EEE guides, standards and recommended practices.

Harmonics-individual and total harmonic distortion, RMS value of a harmonic waveform, Triplex harmonics-important harmonic introducing devices-SMPS, Three phase power converters, arcing devices saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

Unit 2

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, Harmonic, Resonance, 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

Unit 3

Static VAR compensators-SVC and STATCOM Active Harmonic Filtering-Shunt Injection, Filter for single phase, three-phase three-wire and three-phase four-wire systems, d-q domain control of

three phase shunt active filters uninterruptible, power supplies constant voltage, transformers, series active power filtering techniques for harmonic cancellation and isolation

Unit 4

Dynamic Voltage Restorers for sag, swell and flicker problems. Grounding and wiring introduction, NEC grounding requirements-reasons for grounding, typical grounding and wiring problems solutions to grounding and wiring problems

Course Outcomes: -

Students will be able to:

1: Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads

2: To develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components

3: To introduce the student to active power factor correction based on static VAR compensators and its control techniques

4: To introduce the student to series and shunt active power filtering techniques for harmonics.

Suggested reading

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

Course code	**18MEEE-517**
Course title	**ADVANCED MICRO-CONTROLLER BASED SYSTEMS**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

Students will be able to:

1. To understand the architecture of advance microcontrollers
2. To understand the applications of these controllers
3. To get some introduction to FPGA.

Unit 1

Basic Computer Organization, Accumulator based processes: Architecture, Memory Organization, I/O Organization

Micro-Controllers: Intel 8051, Intel 8056- Registers, Memories, I/O Ports, Serial Communication, Timers, Interrupts, Programming.

Unit 2

Intel 8051: Assembly language programming, Addressing, Operations,
Stack & Subroutines, Interrupts, DMA.

Unit 3

PIC 16F877: Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/O and data communication

Digital Signal Processor (DSP): Architecture, Programming, Introduction to FPGA

Unit 4

Microcontroller development for motor control applications, Stepper motor control using micro controller

Course Outcomes

Students will be able to:

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

Suggested reading

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

Course code	**18MEEE-519**
Course title	**OPTIMAL CONTROL THEORY**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives

1. Introduce the basic and fundamental concepts of optimal control theory, controller design
2. Introduction to computational aspects of optimal control

Unit1

Review of Matrix Computations, Maximization of functional of a single and several functions using calculus of variations, Constrained externals, Euler-Lagrange Equation, Necessary conditions for optimal control, Pontryagin's minimum principle and state inequality constraints, Minimum time problems, Minimum control effort problems

Unit 2

Linear quadratic regulator problems, Riccati Equation, Singular intervals in optimal control problems

The principle of optimality, Application of the principle of optimality to decision making, Dynamic programming applied to routing problems

Unit 3

Solving optimal control problems using dynamic programming, Discrete linear regulator problem, Hamilton -Jacobi -Bellman Equation

Unit 4

Numerical Techniques to determine optimal trajectories, Numerical Aspects of Optimization

Course Outcomes

Students will be able to

1. Combine the mathematical methods used in optimal control to derive the solution to variations of the problems studied in the course
2. Use the standard algorithms for numerical solution of optimal control problems and use Matlab to solve fairly simple but realistic problems
3. Integrate the tools learnt during the course and apply them to more complex problems

Suggested reading

1. M. Athans and P. L. Falb, “Optimal Control: An Introduction to the Theory and Its Applications”, Dover Books on Engineering, 2006.
2. D. S. Naidu, “Optimal Control Systems”, CRC Press, 2002.
3. D. Liberzon, "Calculus Of Variations and Optimal Control Theory: A Concise Introduction", Princeton University Press, Dec 2011
4. Frank L. Lewis, DragunaVrabie, Vassilis L. Syrmos, Optimal Control, 3rd Edition, Wiley, 2012

Course code	**18MEEE-521**
Course title	**ROBOTICS AND AUTOMATION**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course objectives

1. To study the various parts of robots and fields of robotics
2. To study the various kinematics and inverse kinematics of robots
3. To study the trajectory planning for robot
4. To study the control of robots for some specific applications

Unit 1

BASIC CONCEPTS: Definition and origin of robotics, different types of robotics, Various generations of robots, degrees of freedom, Asimov's laws of robotics, dynamic stabilization of robots
POWER SOURCES AND SENSORS: Hydraulic, pneumatic and electric drives, Determination of HP of motor and gearing: ratio, variable speed arrangements, path determination, micro machines in robotics, Machine vision, ranging, laser, acoustic, magnetic, fiber optic and tactile sensors

Unit 2

MANIPULATORS, ACTUATORS AND GRIPPERS: Construction of manipulators, manipulator dynamics and force control, Electronic and pneumatic manipulator control circuits, end effectors

Unit 3

KINEMATICS AND PATH PLANNING: Solution of inverse kinematics problem, Multiple solution Jacobian work envelop, hill climbing techniques, Robot programming languages

Unit 4

Manufacturing and non- manufacturing applications, robot cell design, selection of robot Robot Control: Linear methods, Non-linear methods

Course Outcomes

Students will be able to

1. Obtain forward, reverse kinematics and dynamics model of the industrial robot arm
2. Propose and synthesize control law for a given application
3. Classify robots and decide specifications depending on the applications

Suggested reading

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G. “Industrial Robotics”, McGraw-Hill Singapore, 1996
2. Ghosh, “Control in Robotics and Automation: Sensor Based Integration”, Allied Publishers, Chennai, 1998
3. Deb.S.R., “Robotics technology and flexible Automation”, John Wiley, USA 1992
4. Asfahl C.R., “Robots and manufacturing Automation”, John Wiley, USA 1992

Course code	**18MEEE-507**
Course title	**POWER SYSTEM ANALYSIS LAB**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**25**
Total	**50**

Experiments

1 Write a program to form Y bus by Inspection method.
2 Write a program for formation of Y bus by singular matrix transformation
3 Study of load flow methods
    a) Gauss-Siedel method
    b) Newton Raphson Method
4 Write a program for fault analysis for
    a) LG b) LLG c) LLL
5 Write a program for security analysis using load flow & ranking of contingency
6 Write a program for ranking of contingency using overload security analysis
7 Study of ready-made industry standard / commercial software packages for above analysis
8 Write a program to form Zbus matrix.

Course code	**18MEEE-509**
Course title	**ELECTRICAL DRIVES LABORATORY**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**

List of experiments:

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

Course code	**18MEEE-502**
Course title	**DIGITAL PROTECTION OF POWER SYSTEM**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:-Students will be able to:

1. Study of numerical relays
2. Developing mathematical approach towards protection
3. Study of algorithms for numerical protection

Units 1

Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection

Mathematical background to protection algorithms, Finite difference techniques

Units 2

Interpolation formulae, forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier analysis, Fourier series and Fourier transform, Walsh function analysis

Units 3

Basic elements of digital protection, Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers, Conversion subsystem: the sampling theorem, signal aliasing, Error, sample and hold circuits, multiplexers, analog to digital conversion, Digital filtering concepts, The digital relay as a unit consisting of hardware and software

Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm, Fourier and Walsh based algorithms

Units 4

Fourier Algorithm: Full cycle window algorithm, fractional cycle, window algorithm, Walsh function based algorithm, least Squares based algorithms. Differential equation based algorithms; Traveling Wave based Techniques, Digital Differential Protection of Transformers, Digital Line Differential Protection, and Recent Advances in Digital Protection of Power Systems.

Course Outcomes:-

Students will be able to:

1. Learn the importance of Digital Relays
2. Apply Mathematical approach towards protection
3. Learn to develop various Protection algorithms

Suggested reading

1. A.G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009
2. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press, 1999
3. Gerhard Zeigler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006
4. S.R. Bhide, “Digital Power System Protection” PHI Learning Pvt. Ltd.2014

Course code	**18MEEE-504**
Course title	**NON CONVENTIONAL ELECTRICAL ENERGY SYSTEMS**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives

Students will be able to

1. Understand important concepts of energy generation through non-conventional ways
2. Understand different sources like:- Hydro ,Solar , Biomass, Wind , Tidel.
3. Learn about Fusion

Unit 1

Solar energy principles and applications, Efficiency of solar thermal and PV systems, Storage and enrichment, Shadow effect

Unit 2

Biomass: generation characterization, Biogas: aerobic and anaerobic bio-conversion processes, Microbial reactions purification, Properties of biogas
Tidal and wind energy potential and conversion efficiency

Unit 3

Fusion: Basic concepts, Fusion reaction physics, Thermo nuclear fusion reaction criteria, Confinement schemes, Inertial and magnetic confinement fusion, Current status Geothermal: Geothermal regions, Geothermal sources, Dry rock and hot aquifer analysis Geothermal energy conversion technologies, OTEC.

Unit 4

Mini/micro hydro power: classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system, System efficiency
Integrated operation of non-conventional energy sources/Islanding preventive schemes

Course Outcomes

Students will be able to

1. Have knowledge about Hydro,Wind,Biomass ,Tidal sources
2. Learn about Dry rock and Hot Aquifier Analysis
3. Acquire the knowledge about fusion

Suggested reading

1. J.Twidell and T.Weir, “Renewable Energy Resources”, Taylor and Francis Group 2007
2. G.N.Tiwari and MK Ghosal, “Renewable Energy Resources Basic Principles and Application”, Narosa Publishing House 2005.
3. J.A.Duffie and WA Beckman, “Solar Engineering and Thermal Processes”, 2nd Edition John Wiley and sons. 2001.
4. G.N.Tiwari, “Solar Energy”, Narosa Publishing House, 2002.
5. R.A.Gross, “Fusion Energy”, John Wiley and Sons, 1984.

Course code	**18MEEE-512**
Course title	**ARTIFICIAL INTELLIGENCE TECHNIQUES**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives

Students will be able to

1. Understand fuzzy logic, ANN
2. Understand GA & EP

Unit 1

Biological foundations to intelligent Systems: Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks

Unit 2

Fuzzy Logic, Knowledge Representation and Inference Mechanism, Defuzzification methods

Fuzzy Neural Networks and some algorithms to learn the parameters of the network like GA

Unit 3

System Identification using Fuzzy and Neural Network
Genetic algorithm : Reproduction, Cross over, Mutation, Introduction to evolutionary program

Unit 4

Applications of above mentioned techniques to practical problems.

Course Outcomes

1. Students will be able to
2. 1. Learn the concepts of biological foundations of artificial neural networks
3. 2. Learn Feedback networks and radial basis function networks and fuzzy logics
4. 3. Identify fuzzy and neural network
5. 4. Acquire the knowledge of GA

Suggested Reading

1. J M Zurada , “An Introduction to ANN”,Jaico Publishing House
2. Simon Haykins, “Neural Networks”, Prentice Hall
3. Timothy Ross, “Fuzzy Logic with Engg.Applications”, McGraw. Hill
4. Driankov, Dimitra, “An Introduction to Fuzzy Control”, Narosa Publication
5. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Com

Course code	**18MEEE-514**
Course title	**SMART GRIDS**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

Students will be able to:

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

Unit 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

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 .

Unit 2

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)

Unit 3

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

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Qualit y Condit ioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit

Unit 4

Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood 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

Course Outcomes

Students will be able to:

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

Suggested reading

1. Ali Keyhani, “Design of smart power grid renewable energy systems”, Wiley IEEE, 2011
2. Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press , 2009
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, “Smart Grid: Technology and Applications”, Wiley 2012
4. Stuart Borlase, “Smart Grid: Infrastructure, Technology and solutions “ CRC Press
5.A.G.Phadke, “Synchronized Phasor Measurement and their Applications”, Springer \

Course code	**18MEEE-516**
Course title	**HIGH VOLTAGE ENGINEERING**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

Students will be able to:

1. To get introduced to high voltage engineering
2. To understand different high voltage measurements and the necessary instruments

Unit 1

Voltage doubler - cascade circuits, electrostatic machines

Generation of Impulse voltages and curreningle stage and multistage circuits, wave shaping-tripping and control of impulse generators

Unit 2

Generation of switching surge voltage and impulse current Measurement of high, voltages and currents, DC,AC and impulse voltages and currents, DSO-electrostatic and peak, Voltmeters sphere gaps-factors affecting measurements-potential dividers(capacitive and resistive) Series impedance ammeters-rogowski coils-hall effect generators, Digital techniques in HV measurements

Unit 3

Measurement of electric field, Sources of EMI, Principles of EMC, Filtering, Shielding, Grounding techniques

Introduction to relevant national and international standards, Layout and clearances as, well as shielding and grounding of HV lab

Unit 4

Safety regulations for high voltage tests, Calibration of HV measuring instruments Indian Standards for HV clearances. Recent trends in HV Engineering

Course Outcomes:-

Students will be able to:

1. Knowledge about the need for high voltage generation
2. Acquaint with the different methods for generating high voltage AC/DC and impulse voltages and current
3. Knowledge about the measurement techniques for high voltage AC/DC and impulsevoltages and currents
4. To learn sources of EMI and its mitigation techniques
5. Safety precautions to be taken while designing an HV lab

Suggested reading

1. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", McGraw-Hill, 1995.
2. M. Khalifa, "High Voltage Engineering: Theory and Practice", Dekker, 1990
3. H. M. Ryan, "High Voltage Engineering and Testing", Peter Peregrinus, 1994
4. Wadhwa C L.”High Voltage Engineering”, Wiley Eastern Limited, NewDelhi,1994
5. Ott, H.W.,”Noise Reduction Techniques in Electronic Systems”, John Wiley, New York, 1989

Course code	**18MEEE-518**
Course title	**ELECTRIC POWER DISTRIBUTION SYSTEM**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:-Students will be able to:

1. Learning about power distribution system
2. Learning of SCADA System
3. Understanding Distribution Automation

Unit 1

Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Long-term, Power System Loading, Technological Forecasting.

Advantages of Distribution Management System (D.M.S.), Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction

Unit 2 Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation

SCADA: Introduction, Block Diagram, SCADA Applied To Distribution Automation, Common Functions of SCADA, And Advantages of Distribution Automation through SCADA

Unit 3

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits, Bellman's Optimality Principle, Remote Terminal Units, Energy efficiency in electrical distribution & monitoring

Unit 4

Maintenance of Automated Distribution Systems, Difficulties in Implementing Distribution, Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation

Course Outcomes:-Students will be able to:

1. Knowledge of power distribution system
2. Study of Distribution automation and its application in practice

3. To learn SCADA system

Suggested reading

1. A.S. Pabla, “Electric Power Distribution”, Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M.K. Khedkar, G.M. Dhole, “A Text Book of Electrical power Distribution Automation”, University Science Press, New Delhi
3. Anthony J Panseni, “Electrical Distribution Engineering”, CRC Press
4. James Momoh, “Electric Power Distribution, automation, protection & control”, CRC Press

Course code	**18MEEE-520**
Course title	**ADVANCE CONTROL SYSTEM**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives

1. The course provides glimpses into the advanced methods of modeling and analysis of the dynamical systems
2. The course is a strong step in inculcating the research aptitude in the students

Unit 1

Math Modelling of Dynamical Systems: Newtonian and Lagrangian approaches, Concept of dynamical state of a system, Concept of equilibrium point, linearization of non-linear model.

Review of Linear Algebra concepts: Field, Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix, Eigen value and Eigen vector of a matrix, similarity transform, Diagonalisation

Unit 2

Modern Control Analysis: Concept and computation of systems modes, controllability theorem and its proof, Observability theorem and its proof, Controllable and observable subspaces

Stability Analysis: Stability of linear systems, stability types and their definitions for any general system, Stability of an equilibrium point, Lyapunov stability theory for LTI systems, Quadratic forms and Lyapunov functions

Unit 3

Modern Control Design: Converting the math model to controllable canonical form and its use for pole placement, Concept of linear observer and its design, Design of reduced order observer, Compensator design using separation principle, Poles of compensator, Open loop and close-loop systems

Unit 4

Optimal Control Theory: Introduction to the philosophy of optimal control, formulation of optimal control problem, different performance criterion, linear quadratic regulator (LQR) and optimum gain matrix, Riccati equations, conceptual models and statistical models for random processes, Kalman filter

Course Outcomes

Students will be able to

1. Apply the concepts of linear algebra and their applications to control system
2. Analyze the system dynamics and Lyapunov stability theory
3. Design linear quadratic controller

Suggested reading

1. Bernard Friedland, “Control System Design: An Introduction to State-Space Methods”, Dover Publications, Inc. Mineola, New York, 2012
2. Thomas Kailath, “Linear Systems”, Prentice-Hall Inc., New Jersey, 1986
3. M. Gopal, “Modern Control System Theory”, , New Age International (P) Limited, New Delhi, 2000

Course code	**18MEEE-522**
Course title	**WIND AND SOLAR SYSTEMS**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:-

Students will be able to:

1. To get exposure to wind and solar systems
2. To understand the factors involved in installation and commissioning of a Solar or Wind plant.
3. To learn the dynamics involved when interconnected with power system grid

Unit 1

Historical development and current status, characteristics of wind power generation, network integration issues

Generators and power electronics for wind turbines, power quality standards for wind turbines, Technical regulations for interconnections of wind farm with power systems.

Unit 2

Isolated wind systems, reactive power and voltage control, economic aspects.

Impacts on power system dynamics, power system interconnection

Unit 3

Introduction of solar systems, merits and demerits, concentrators, various applications

Unit 4

Solar thermal power generation, PV power generation, Energy Storage device, Designing the solar system for small installations.

Course Outcomes:-

Students will be able to:

1. Appreciate the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems
2. Demonstrate the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems

3. Demonstrate the knowledge of physics of solar power generation and the associated issues
4. Identify, formulate and solve the problems of energy crises using wind and solar energy

Suggested reading

1. Thomas Ackermann, Editor, “Wind power in Power Systems”, John Willy and sons ltd.2005
2. Siegfried Heier, “Grid integration of wind energy conversion systems”, John Willy and sons ltd., 2006
3. K. Sukhatme and S.P. Sukhatme, “Solar Energy”. Tata MacGraw Hill, Second Edition, 1996

Course code	**18MEEE-506**
Course title	**POWER SYSTEM PROTECTION LAB**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**25**
Total	**50**

Power System Protection Lab

Experiments

1 Apply a relay for phase sequence, phase failure and voltage asymmetry to a three-phase circuit
2 To use a timer with different time functions to extend the protection relays operation
3 Modeling of Differential Relay using MATLAB
4 Radial Feeder Protections
5 Parallel Feeder Protections
6 Principle of Reverse Power Protection
7 Differential Protection of Transformer
8 To the study time Vs voltage characteristics of over voltage induction relay

Course code	**18MEEE-508**
Course title	**NON-CONVENTIONAL ENERGY SOURCES LAB**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**25**
Total	**50**

Experiments

1 Determine the efficiency of Solar PV Grid-Tied system.
2 Determine the efficiency of Wind Energy System.
3 Field Visit to Solar Street Lighting System.
4 Determine the power output of a biogas plant
5 Study of a geothermal system
6 Determine the efficiency of a fuel cell
7 Determine the efficiency of a mini hydro plant
8 Study of grid integration of multiple renewable energy sources

Course code	**18MEEE-510**
Course title	**MINI-PROJECT**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**

Course Outcomes: At the end of the course:

1. Students will get an opportunity to work in actual industrial environment if they opt for internship.
2. In case of mini project, they will solve a live problem using software/analytical/computational tools.
3. Students will learn to write technical reports.
4. Students will develop skills to present and defend their work in front of technically qualified audience.

Syllabus Contents:

Students can take up small problems in the field of mechanical engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.