Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University) Andheri (W), Mumbai – 400058

COURSE CONTENTS

(M.Tech. in Power Electronics & Power System)

Semester I and II

Academic Year: 2019-20

List of Courses

Course Code: PC-MTPX101Course:-Advanced Power Electronics (AY 2019-20)

Course Objectives:

1. To understand the switching behaviour of power electronics devices
2. To study the different power electronics circuits such as AC-DC, DC-AC converters
3. To demonstrate the design of power electronics circuit for different applications.

Course Outcomes:

1. Able to classify and demonstrate the switching behaviour of the power electronic devices
2. Able to analyse, design and select proper converters for various applications in electrical engineering

Course content:

Module No.	Course Content	Hours
1	**Advanced solid state devices:** MOSFETs, IGBT, GTO, IGCT etc. Power modules, intelligent power modules, gating circuits. Thermal design, protection. Digital signal processors used in their control	04
2	**Non-isolated dc-dc converters:** Buck, boost, Buck-boost, Cuk, SEPIC, Zeta in DCM and CCM **Isolated dc-dc converters:** Flyback, forward, Cuk, SEPIC, Zeta, half bridge, push-pull. Bridge in DCM and CCM Non-Isolated and Isolated dc-dc converters application in SMPS, UPS, welding and lighting systems. Analysis and design methodology	08
3	**Modelling and control of DC to DC converters:** Review of classical methods of modelling. State space model of various ideal and non-ideal dc to dc converters, state space averaging techniques, small signal analysis, transfer function, feedback control, compensator design, voltage feed forward PWM control, current mode control, slope compensation, comparison of current mode and voltage mode control.	06
4	**Three-phase improved power quality dc-ac converters:** VSC, multilevel VSCs, multi pulse VSCs, PWM CSC (current voltage source converters). Analysis and design methodology **Multi pulse ac-dc converters:** Diode and thyristor based converters.	06
5	Implementation aspects, modification of power circuit for four quadrant operation of inverter	06
6	**Applications of power electronic converters:** Residential applications, Industrial applications, Electric utility applications, Renewable energy technology applications.	06
7	**Soft switching techniques:** loss reduction in power electronic switches. Soft switching in DC-DC converters, Resonant soft switching converters.	06

	Soft switching techniques in PWM converters: Analysis and design methodology of lossless, passive soft switching methods for PWM converters.	

References

1. N. Mohan, T. M. Undeland & W. P. Robbins, "Power Electronics: Converter, Applications & Design", John Wiley & Sons, 3rd edition sept. 2002, © 2003.
2. M.H. Rashid, "Power Electronics: Circuits Devices and Applications", Prentice Hall of India, 3rd edition 1994.
3. B. K. Bose, "Power Electronics & A.C. Drives", Prentice Hall, 2002.
4. Xinbo Ruan "Soft-switching PWM Full-Bridge converters Topologies, Control & Design", John Wiley & Sons, Inc. 1st edition April 2014, © 2018

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PC-MTPX102 Course:-Computer Aided Power System Analysis (AY 2019-20)

Course Objectives

1. To understand analysis of power systems using Computer methods.
2. To understand the advance techniques in the solution of power flow problem.
3. To understand the solution methods and techniques involved in power system analysis.
4. To understand the behaviour of power system under healthy and faulty condition.

Course Outcomes:

1. Able to appraise the use of computational methods in the solution of power flow problem
2. Able to investigate the behaviour of power system under different operating conditions.

Course content:

Module	Course Contents	Hours
1.	**General Introduction:** Modern Power systems Operation and Control; Different types of Power System Analysis. Introduction to AC Power Flow Analysis, Modelling of Power System Components, Power Flow Equations, and Formation of Y bus Matrix.	**04**
2.	**AC Power Flow Analysis:** Power Flow Solution Algorithms, Newton Raphson Load Flow Method, Fast Decoupled Load Flow Method And DC Load Flow Method, AC-DC System Power Flow Analysis- Sequential and Simultaneous Solution Algorithms.	**08**
3.	**Sparse Matrices:** Sparsity directed Optimal Ordering Schemes, Solution Algorithms – LU Factorization, Bi factorization and Iterative Methods.	**04**
4.	**Analysis of Faulted Power System:** Symmetrical and Asymmetrical Faults, Z bus Formulation, Short Circuit Analysis of Large Power Systems using Z bus, Analysis of Open Circuit faults.	**08**
5	**Security Analysis:** Basic Concepts, Static Security Analysis at Control Centres, Contingency Analysis, Contingency Selection.	**06**
6	Power system state estimation, method of least square, statistics, errors and estimates, test for bad data, network topology processing.	**06**
7	**Voltage Stability Analysis**: Basic Concepts of Voltage Stability Analysis. Optimal power flow: Introduction, solution of OPF, linear sensitivity analysis, linear programming methods, security constrained OPF	**06**

Reference Books:

1. O. I. Elgerd, Electric Energy Systems Theory – An Introduction, McGraw-Hill, 1988.
2. A.R. Bergen and Vijay Vittal, Power Systems Analysis, Pearson Education Asia, 2001.
3. J.J. Grainger and W.D. Stevenson, Power System Analysis, McGraw-Hill, New York, 1994.
4. I.J. Nagrath and D.P. Kothari, Power System Engineering, Tata McGraw Hill Publishing Co.1994.
5. J.D. Glover, M. Sarma and T.J. Overbye, Power System Analysis and Design, Fourth Edition, Thomson Engineering Press, 2008.
6. P. Kundur, Power System Stability and Control, McGraw Hill, 1994.
7. **M. Crow, Computational methods for Electric Power Systems, 2nd edition, 2010**

Tentative syllabus for Examinations:

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PE-MTPX101 Course: Distributed Generation and Micro Grid (AY 2019-20)

Course Objectives

1. To illustrate the concept of distributed generation.
2. To analyse the impact of grid integration.
3. To study concept of Micro grid and its configuration

Course outcomes

1. Review the conventional power generation
2. Analyse the concept of distributed generation and installation
3. Design the grid integration system with conventional and non-conventional energy sources
4. Design the dc and ac micro grid
5. Analyse the planning and operational issues related to Distributed Generation & micro grid.

Course content:

Sr. No.	Contents	Hours
1	**Introduction:** Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. Distributed vs Central Station Generation Sources of Energy **Distributed generations:** Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants	06
2	**Impact of grid integration** Requirements for grid interconnection, limits on operational parameters, voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.	06
3	**Basics of a micro grid:** Concept and definition of micro grid, micro grid drivers and benefits, review of sources of micro grids, typical structure and configuration of a micro grid, AC and DC micro grids, Power Electronics interfaces in DC & AC micro grids.	06
4	**Control and operation of micro grid:** Modes of operation and control of micro grid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, micro grid communication infrastructure,	06
5	Impact of Distributed Generation on the Power System. Power Quality	

	Disturbances. Power quality issues in micro grids, regulatory standards, Micro grid economics.	04
6	Control of DG inverters, phase locked loops, current control and DC voltage control for standalone and grid parallel operations. Protection of the converter Relaying and protection: distributed generation interconnection relaying, sensing using CTs and PTs.	06
7	DG planning cost implications of power quality, cost of energy and net present value calculations and implications on power converter design. Economics of Distributed Generation-Case Studies	08

Reference books

1. Technical literature-papers published in power electronics related journals and IEEE standards.
2. Ned Mohan, Tore M. Undeland, William P Robbins, "Power Electronics: Converters, Application, and Design". Wiley, 2002.
3. Ranjan Rakesh, Kothari D.P, Singal K.C, "Renewable Energy Sources and Emerging Technologies",2nd Ed. Prentice Hall of India ,2011
4. Math H. Bollen, Fainan Hassan," Integration of Distributed Generation in the Power System", July 2011, Wiley –IEEE Press
5. Loi Lei Lai, Tze Fun Chan, "Distributed Generation: Induction and Permanent Magnet Generators", October 2007, Wiley-IEEE Press.
6. Roger A. Messenger, Jerry Ventre, "Photovoltaic System Engineering", 3rd Ed, 2010

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PE-MTPX102 Course: Power Electronics Applications to Renewable Energy (AY 2019-20)

Course Objectives:-

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. Learning the dynamics involved when interconnected with power system grid

Course Outcomes:-

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

Course content:

Sr. No.	Content	Hours
1	**Solar Photovoltaic (PV) Systems**: PV cell concepts, Mathematical representation and basic performance characteristic, performance with series parallel combination of cells - with identical and non-identical cell combination. Energy Storage devices.	**06**
2	**Power Electronics for PV applications:** Maximum Power point Tracking (MPPT) – analysis. Algorithm for MPPT.	**06**
3	. **Analysis and Design** of solar system for small & large installations- case study.	**06**
4	**Wind Energy Systems:** Basic concept and Mathematical representation and basic performance characteristics and control strategy.	**06**
5	Generators and power electronics for wind turbines, power quality standards for wind turbines, Technical regulations for interconnections of wind farm with power systems. Isolated wind systems, reactive power and voltage control, economic aspects	**06**
6	Analysis and Design of wind energy system for small & large installations- case study	**06**
7	Grid connected wind and Solar Energy conversion systems: Grid connectors, connection issues, its impacts on power system quality & dynamics -analysis.	**06**

Reference Books:

1. Thomas Ackermann, Editor, "Wind power in Power Systems", John Wiley and sons ltd.2005
2. Siegfried Heier, "Grid integration of wind energy conversion systems", John Wiley and sons ltd., 2006
3. K. Sukhatme and S.P. Sukhatme, "Solar Energy". Tata McGraw Hill, Second Edition, 1999
4. Mukund R Patel " Wind and Solar Power Systems: Design, Analysis, and Operation' 2nd edition CRC Taylor Francis, 2006.

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PE-MTPX103 Course:- Modelling and Analysis of Electrical Machine (AY 2019-20)

Course Objectives:-

Students will be able to:

1. To understand the representation electrical machines by the set of mathematical equations.
2. To realize the real behaviour of electrical machines.
3. To study the concepts of space phasors and frame transformation

Course Outcomes:-

1. To implement the mathematical representation of electrical machines.
2. Demonstrate the reference frame theory and its application for representation of induction machine model.
3. Analyse the behaviour of induction machine from its mathematical model

Course content:

Module No.	Course Content	Hours
1	Magnetically Coupled Circuits: Coupled Circuit with and without Leakage Linear Magnetic System, Nonlinear Magnetic System, Computer Simulation of Coupled Circuits with and without leakage	05
2	Electromechanical Energy Conversion: Energy Relationship, Energy in Coupling Fields, Graphical Interpretation of Energy Conversion, Electromagnetic and Electrostatic Forces and Torques, Steady State and Dynamic Performance of and Electromechanical System	06
3	Machine Windings and Air Gap EMF, Winding Inductances and Voltage Equations: Synchronous Machine, Induction Machine	05
4	Reference Frame Theory: Introduction, Equations of Transformation-Change of Variables, Stationary Circuit Variables Transformed to the Arbitrary Frame: Resistive Elements, Inductive Elements, Capacitive Elements, Commonly used Reference Frame, Transformation between Reference Frames, Transformation of a Balanced Set, Balanced Steady State Phasor Relationships, Balanced Steady State Voltage Equations, Variables Observed from Several Frame of Reference	08
5	Theory of Symmetrical Induction Machines: Voltage Equations in Machine Variables, Torque Equations in Machine Variables, Equations of Transformation for Rotor Circuits, Voltage Equations in Arbitrary Reference Frame Variables	05
6	Symmetrical Induction Machines Steady State and Dynamic Characteristics: Analysis of Steady State Operation, Free Acceleration Characteristics, Free Acceleration Characteristics Viewed from Various Reference Frames, Dynamic Performance during Sudden Changes in Load Torque, Dynamic	08

	Performance during a Three Phase fault at Machine Terminals	
7	Introduction to Synchronous Machine Theory: Voltage Equations in Machine Variables, Torque Equations in Machine Variables, Stator Voltage Equations in Arbitrary Reference Frame Variables, Voltage Equations in Rotor Reference Frame Variables- Parks Equations, Torque Equation in Substitute Variables, Rotor Angle and Angle between Rotors.	**05**

Reference Books:

1. Charles Kingsley, Jr., A.E. Fitzgerald, Stephen D. Umans, "Electric Machinery", Tata McGraw Hill, Seventh edition, 2013.
2. R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India 2015.
3. Ned Mohan, "Advanced electrical drives Analysis, Control and Modeling using Simulink", Wiley, 2014.
4. P. C. Krause, "Analysis of Electrical Machinery and Drive System," Wiley IEEE Press, Third edition, 2013.

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Objectives:-

1. The course will give a comprehensive overview of power system reliability.
2. Evaluation of conventional and non-conventional power generation system reliability.
3. To learn Modern Trends in Power system Reliability analysis.

Course Outcomes:-

1. Able to have a thorough understanding of the main principles in power system reliability analysis, knowledge of different methods and tools for reliability analysis
2. Able to interpret some advanced concepts of power system reliability that will be useful for engineering professional practice in the power sector operation and planning.
3. Able to model and analyse power system with respect to reliability of supply.

Course content:

Module No.	Course Content	Hours
1	Power system Reliability: Introduction, Basic reliability Concepts, Terms and Definitions, outage, failure rate, and outage rate availability, unavailability, Reliability function, Mean time to failure, Hazard Rate Function, Bathtub Curve. Hierarchical levels of Power system Functional Zones	06
2	Reliability of Systems: Serial Configuration, Parallel Configuration, Combined Series – Parallel Systems, System Structure Faction, Minimal Cuts and Minimal Paths. Reliability models, Markov process, Monte Carlo Simulation.	06
3	Generation system reliability analysis: Introduction, Probabilistic generating unit models, Probabilistic load models, Effective load, Reliability analysis for an Isolated system	06
4	Generating Capacity reliability Evaluation: Static Generating capacity: Introduction, Basic probability methods and Frequency & Duration method, capacity outage probability table, recursive algorithm, Evaluation of: loss of load indices, Loss of load expectation & Loss of energy Spinning Generating capacity: Introduction, load forecast uncertainty de rated capacity levels	06
5	. Reliability evaluation of: Grid connected PV and Concentrated Solar Power (CSP) system, Wind energy system - Case study. Cost estimation, Economic and Technical Analysis of Distributed	06

	Generation Connection: Wind Farm & PV system Case Study	
6	Distributed Generation and its impacts on distribution system and reliability & Evaluation technique – Case study.	**06**
7	Modern Trends in Power system Reliability analysis, XML Annotations for power system reliability data representation, Web service based power system reliability data generation model. XMLised Power System Reliability Data Generation Service Interface & Implementation	**06**

Reference Books:

1. Roy Billinton and Ronald N. Allan, "Reliability Evaluation of Power System," Plenum, Press, 2nd edition, 1996.
2. R.L. Sullivan, "Power System Planning," Tata McGraw Hill Publishing Company, 1st edition,1997.
3. Roy Belington and Ronald N Allan, "Reliability Assessment of Large Electric Power Systems", Kluwer academic publishers, 2nd edition 1995.
4. X. Wang and J.R. McDonald, "Modern Power System Planning", McGraw Hill, 1994.
5. Ali Chowdhury, Don Koval, "Power distribution system reliability- Practical methods and applications", Wiley- IEEE press, April 2011.

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Objectives:

1. To understand what is meant by restructuring of the electricity market
2. Understand the need for deregulation of the electricity market
3. Understand the money, power & information flow in a deregulated power system

Course outcomes:

1. Able to describe various types of regulations in power systems.
2. Identify the need of regulation and deregulation.
3. Define and describe the Technical and Non-technical issues in Deregulated Power Industry.
4. Identify and give examples of existing electricity markets.
5. Classify different market mechanisms and summarize the role of various entities in the market

Course content:

Module No.	Course Content	Hours
1	**Introduction to restructuring of power industry:** Reasons for restructuring / deregulation of power industry; Understanding the restructuring process; Introduction to issues involved in deregulation; Reasons and objectives of deregulation of various power systems across the world	06
2	**Components of Restructured Power Systems:** Generation companies (GENCOS), Distribution companies (DISCOS), and Transmission companies (TRANSCOS), Independent System Operator (ISO), Power Exchange (PE), Scheduling Coordinators (SCs).	06
3	**Fundamentals of Economics:** Introduction, Consumer behaviour, Supplier Behaviour, Market equilibrium; Short-run and Long-run costs; Various costs of production; Relationship between short-run and long-run average costs; Perfectly competitive market.	06
4	**Electricity Market Models:** Traditional power delivery chain, Power delivery chain in Electricity market – Independent System Operator (ISO) - Maximalist ISO – Minimalist ISO; Pool Market – Competitive Markets: Bilateral market – power exchange market – Hybrid market; PX and ISO: Functions and Responsibilities – Day- Ahead Electricity market, Real-time Balancing market	06
5	**Open access transmission system:** Available Transfer Capability (ATC)– Total Transfer Capability (TTC) – Transmission Reliability Margin (TRM) – Capacity Benefit Margin (CBM) – Existing Transmission Commitments (ETC) – Illustration Using a Small Power System Congestion Management: CM in Traditional and Market Scenario, Ancillary services,	06

	Standard market design, Distributed generation in restructured markets	
6	**Reforms in Indian power sector:** Framework of Indian Power Sector – Reform Initiatives during 1990–1995 – The Availability Based Tariff (ABT) – Demand Side Management (DSM) –The Electricity Act 2003 – Open Access issues – Power exchange – Reforms in near future.	**06**
7	Recent trends in Restructuring-Case studies Effect of industry restructuring on system reliability. New requirement for computation tools and software systems in electricity markets. IT applications in restructured markets.	**06**

Reference books:

1. Lorrin Philipson, H. Lee Willis, "Understanding electric utilities and de-regulation", Marcel Dekker Pub.1998.
2. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley and Sons, 2002
3. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolean, "Operation of restructured Power systems", Kluwer Academic Pub., 2001.
4. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems operation, trading and volatility", Marcel Dekker

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PL-MTPX101 Course: Advanced Power Electronics Laboratory (AY 2019-20)

Course Objectives:

1. To realize of the real world problem of power electronics systems.
2. To study model of the power electronics systems.
3. To understand the techniques of voltage control using PWM techniques

Course Outcome

1. Able to judge the results of the simulation study
2. Able to simulate the given electrical system for various operating conditions.

Course Content:

Laboratory work to include at least Eight Matlab Simulations based on every module.

References

1. N. Mohan, T. M. Undeland & W. P. Robbins, "Power Electronics: Converter, Applications & Design", John Wiley & Sons, 3rd edition sept. 2002, © 2003.
2. M.H. Rashid, "Power Electronics: Circuits Devices and Applications", Prentice Hall of India, 3rd edition 1994.
3. B. K. Bose, "Power Electronics & A.C. Drives", Prentice Hall, 2002.
4. Xinbo Ruan "Soft-switching PWM Full-Bridge converters Topologies, Control & Design", John Wiley & Sons, Inc. 1st edition April 2014, © 2018

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Course Code: PL-MTPX102 Course: Computer Aided Power System Analysis Laboratory (AY 2019-20)

Course Objectives

1. To understand analysis of power systems using Computer methods.
2. To understand the advance techniques in the solution of power flow problem.
3. To understand the solution methods and techniques involved in power system analysis.
4. To understand the behviour of power system under healthy and faulty condition.

Course Outcomes:

1. Able to appraise the use of computational methods in the solution of power flow problem
2. Able to investigate the behaviour of power system under different operating conditions.

Course Content:

Laboratory work to include at least Eight Simulations based on every module

Reference Books:

1. O. I. Elgerd, Electric Energy Systems Theory – An Introduction, McGraw-Hill, 1988.
2. A.R. Bergen and Vijay Vittal, Power Systems Analysis, Pearson Education Asia, 2001.
3. J.J. Grainger and W.D. Stevenson, Power System Analysis, McGraw-Hill, New York, 1994.
4. I.J. Nagrath and D.P. Kothari, Power System Engineering, Tata McGraw Hill Publishing Co.1994.
5. J.D. Glover, M. Sarma and T.J. Overbye, Power System Analysis and Design, Fourth Edition, Thomson Engineering Press, 2008.
6. P. Kundur, Power System Stability and Control, McGraw Hill, 1994.

Course Code: PL-MTPX103 Course: Digital Simulation of Power Electronics System Laboratory (AY 2019-20)

Course Objectives:

1. To realize of the real world problem of power electronics systems.
2. To study model of the power electronics systems.
3. To understand the techniques of voltage control using PWM techniques

Course Outcome

1. Able to judge the results of the simulation study
2. Able to simulate the given electrical system for various operating conditions.

Course content:

Module No.	Course content	Hours
1	Review of numerical methods. Application of numerical methods to solve transients in D.C. switched R, L, R-L, R-C and R-L-C circuits. Extension to AC circuits.	02
2	Modelling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply. Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation. Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits and control.	06
3	Simulation of inverter fed induction motor drives.	04
4	Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers, converters with self-commutated devices- simulation of power factor correction schemes.	04
5	Simulation of converter fed dc motor drives, Simulation of thyristor choppers with voltage, current and load commutation schemes, Simulation of chopper fed D.C. motor.	04
6	Simulation of single and three phase inverters with thyristors and self-commutated devices	06
7	Space vector representation, pulse-width modulation methods for voltage control, waveforms.	04

References:

1. Simulink Reference Manual, Mathworks, USA.
2. Robert Erickson, "Fundamentals of Power Electronics", Chapman & Hall, 1997.
3. Issa Batarseh, "Power Electronic Circuits", John Wiley, 2004
4. M. H. Rashid, "Power Electronics: Circuits Devices and Applications", Prentice Hall of India, 1994.

Course Objectives:

1. Understand research problem formulation.
2. Analyse research related information
3. Follow research ethics

Course Outcomes:

Understand that today's world is controlled by Computer, Information

1. Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
2. 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.
3. 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.

Course contents:

Module No.	Course Content	Hours
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	03
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	03
3	**Fundamentals of Economics:** Introduction; Consumer behviour; Supplier behviour; Market equilibrium; Short-run and Long-run costs; Various costs of production; Relationship between short-run and long-run average costs; Perfectly competitive market.	03
4	**Nature of Intellectual Property** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT	03
5	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology	

	Patent information and databases. Geographical Indications.	**03**
6	Ancillary services, Standard market design, Distributed generation in restructured markets	**03**
7	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.	**03**

Reference Books:

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

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 6

Course Code: AU-MTPX101 Course: English for research paper writing (AY 2019-20)

Course objectives:
Students will be able to:
1. Understand that how to improve your writing skills and level of readability.
2. Learn about what to write in each section.
3. Understand the skills needed when writing a Title.

Course contents:

Module No.	Course Content	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	04
2	Clarifying who did what, Highlighting your findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts	04
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	04
4	key skills needed for writing a Title, an Abstract, an Introduction and a Review of the Literature	04
5	Key skills needed when writing the Methods, Results, Discussion and Conclusions.	04
6	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.	04

Recommended Books:

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

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 6

Course Code: AU-MTPX102 Course: Constitution of India (AY 2019-20)

Course Objective :

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. 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.
3. 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.

Course Outcome: Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. 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.
4. Discuss the passage of the Hindu Code Bill of 1956

Course Contents

Module No	Description	Hours
1	History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working).	04
2	Philosophy of the Indian Constitution: Preamble, Salient Features.	04
3	Contours of Constitutional Rights & Duties: Fundamental Rights. Right to Equality. Right to Freedom. Right against Exploitation. Right to Freedom of Religion. Cultural and Educational Rights. Right to Constitutional Remedies. Directive Principles of State Policy. Fundamental Duties	04
4	Organs of Governance: Parliament Composition Qualifications and Disqualifications Powers and Functions Executive President Governor Council of Ministers Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions	04
5	Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.	05
6	Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	06

Reference Books:

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

2) Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3) M. P. Jain, Indian Constitutional Law, 7th Edn., Lexisnexis, 2014.

4) D.D. Basu, Introduction to the Constitution of India, Lexisnexis, 2015.

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 6

Course Code: PC-MTPX201 Course: Power System Dynamics and Control (AY 2019-20)

Course Objectives:

1. To study the stability considerations in power system.
2. To understand the different stability of power system and multi-machine stability concept
3. To study of voltage stability, PV, QV and PQ curves
4. To study of improving the stability of power system

Course Outcomes:

1. Able to understand and appreciate the stability concept in the power network.
2. Able to apply the effects of various electrical parameter on stability

Course contents:

Module No.	Course content	No. of Hrs
1	Introduction to Power System Stability • Power system operation and control • Stability problems faced by power systems • Impact on power system operation control • Concept of equilibrium, small and large Disturbance in stability • Analysis using Numerical Integration Techniques	**06**
2	Modelling of a Synchronous Machine • Physical characteristics • Rotor position dependent Model • D-Q transformation, Parks transformation • Model with Standard parameters • Steady state Analysis of synchronous machine • Short circuit transient analysis of a synchronous machine • Synchronous machine connected to infinite Bus	**06**
3	Modelling of Exciters and prime mover system, transmission lines and load	**06**
4	Transient stability-swing equation-equal area criterion-solution of swing equation-Numerical methods-Euler method-Runge-Kutta method-critical clearing time and angle-effect of excitation system and governors Application of power system stability	**06**
5	Multi machine stability –extended equal area criterion-transient energy function approach.	**06**
6	Methods of improving stability – transient stability enhancement – high speed fault clearing – steam turbine fast valving-high speed excitation systems- small signal stability enhancement power system stabilizers – voltage stability enhancement – reactive power control.	**06**

7	Voltage stability – generation aspects - transmission system aspects – load aspects – PV curve – QV curve – PQ curve – analysis with static loads – load ability limit – sensitivity analysis-continuation power flow analysis - Instability mechanisms-examples.	**06**

Reference Books:

1. Kundur, P., "Power System Stability and Control", McGraw-Hill International Editions, 1994.
2. Anderson, P.M. and Fouad, A.A., "Power System Control and Stability", John Wiley, second edition 2003.
3. Van Cutsem, T. and Vournas, C., "Voltage Stability of Electric Power Systems", Springer
4. P. Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.
5. K. R. Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.

Sr. No.	Examination	Module
1	Test I	1,2,3
2	Test II	4,5,6
3	Final Examination	1 to 7

Course Code: PC-MTPX202 Course: Advanced Control of Electrical Drives (AY 2019-20)

Course Objectives:

1. To study the torque-speed characteristics of AC and DC drives and different types of load
2. To discuss modification of torque speed characteristics of AC and DC motors as per load requirements.
3. To understand the power modulators and control strategies
4. To study steady state stability of the motor load system and higher level control of ac drives.

Course Outcomes:

1. Able to apply the knowledge of electrical drives system for various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology.
2. Able to understand the basic requirements placed by mechanical systems on electric drives.
3. Able to apply the basic principles of power electronics in drives using switch-mode converters and pulse width modulation to synthesize the voltages in dc and ac motor drives.
4. Able to understand the need of modification of the torque speed characteristics of machines. Describe the operation of induction machines in steady state and dynamic condition.
5. Able to appreciate the speed control of induction motor drives in an energy efficient manner using power electronics with higher level control technique such as vector control.

Course contents:

Module No.	Course content	No. of Hrs
1	Review: Basics of AC and DC Drives	**04**
2	Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with freewheeling diode; Implementation of braking schemes; Drive employing dual converter. Constant torque and constant horsepower operations.	**06**
3	Modeling of DC drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feedback elements- Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison. Simulation of converter and chopper fed DC drive.	**06**
4	AC voltage controller fed induction machine operation – Energy conservation issues – V/f operation theory – requirement for slip and stator voltage compensation. CSI fed induction machine – Operation and characteristics.	**08**
5	Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation.	**06**
6	Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy.	**06**

7	Synchronous motor control - Brush and Brushless excitation – Load Commutated inverter fed drive.	**06**

References:

1. G. K. Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Jersey, 1989.
2. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice- Hall of India Pvt. Ltd., New Delhi, 2003.
3. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2001.
4. B. K. Bose "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
5. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill Publishing company Ltd., New Delhi, 2002.

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PE-MTPX201 Course: Advanced Techniques in Power System Protection (AY 2019-20)

Course Objectives

Students will be able to

- Understand the art and science of numerical relay technology.
- Demonstrate the hardware description of relaying system.

Course Outcomes

- Exposure to the modern protection practices.
- Appreciate new trends in relay technologies.

Module No.	Content	Hours
1.	**Review of Relaying Practices:** Evolution of digital relays from electromechanical relays, Review of protection philosophies for transmission lines, generators and transformers. Modeling of Current and voltage transformers	5
2.	**Mathematical background to protection algorithms:** Finite difference Techniques, Interpolation formulae: Forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier series and Fourier transform	8
3.	**Numerical Relay :** architecture, sampling theorem, anti-aliasing filter, Fourier Algorithm, Full cycle window algorithm for phasor estimation	5
4.	**Transmission Line Protection:** Distance relay scheme for three phase line, Different relay algorithms for distance protection, Out of step blocking and tripping schemes.	8
5.	**Digital differential Protection**: protection of generator, transformer, bus bar protection, Travelling wave based protection schemes.	8
6.	**Adaptive Relaying:** Need for adaptive relaying, Adaptive relaying for transmission lines, transformer, Auto-reclosing.	4
7.	**Wide Area Measurement Applications:** WAMS architecture, WAMS based out of step relaying, supervision of back up zones, Intelligent load shedding, Intelligent islanding. Travelling Wave based techniques	4

Reference Books

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 Ziegler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006
4. S.R. Bhide “Digital Power System Protection” PHI

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Objectives

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

Course Outcomes

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

Course contents:

Module No.	Course content	No. of Hrs
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. Threats and security in smart grid	**4**
2	Introduction to Smart Meters. Real Time Pricing. 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 Auto	**6**
3	Geographic Information System (GIS). Intelligent Electronic Devices (IED) & their application for monitoring & protection. Smart storage like Battery. SMES. Pumped Hydro. Compressed Air Energy Storage. Wide Area Measurement System (WAMS). Phase Measurement Unit (PMU)	**8**
4	Concept of micro-grid. Need & applications of micro-grid Formation of micro-grid. Issues of Interconnection. Protection & control of micro-grid. Plastic & Organic solar cells. Thin film solar cells. Variable speed wind generators. Fuel-cells. Micro-turbines. Captive power plants. Integration of renewable energy sources.	**6**
5	Power Quality & EMC in Smart Grid. Power Quality issues of Grid connected Renewable Energy Sources. Power Quality Conditioners for Smart Grid. Web based Power Quality monitoring. Power Quality Audit	**6**
6	Advanced Metering Infrastructure (AMI). Home Area Network (HAN), Neighbourhood Area Network (NAN). Wide Area Network (WAN). Bluetooth. ZigBee.	**6**
7	GPS, Wi-Fi. Wimax based communication. Wireless Mesh Network.	**6**

	Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols	

Reference Books

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. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "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

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PE-MTPX203 Course: Mathematical methods for Power Engineering (AY 2019-20)

Course Objectives:

1. To understand the relevance of mathematical methods to solve engineering problems.
2. To understand how to apply these methods for a given engineering problem.

Course Outcomes:

1. Knowledge about vector spaces, linear transformation, eigenvalues and eigenvectors of linear operators
2. To learn about linear programming problems and understanding the simplex method for solving linear programming problems in various fields of science and technology
3. Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems
4. Understanding the concept of random variables, functions of random variable and their probability distribution
5. Understand stochastic processes and their classification

Course contents:

Module No.	Course content	No. of Hrs
1	Vector spaces, Linear transformations Matrix representation of linear transformation	6
2	Eigenvalues and Eigenvectors of linear operator	4
3	Linear Programming Problems Simplex Method Duality Nonlinear Programming problems	7
4	Unconstrained Problems Search methods Constrained Problems	7
5	Lagrange method Kuhn-Tucker conditions Random Variables Distributions	7
6	Independent Random Variables Marginal and Conditional distributions	7
7	Elements of stochastic processes	4

Reference books

1. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1992
2. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, 2004
3. Irwin Miller and Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn, PHI, 2002
4. J. Medhi, "Stochastic Processes", New Age International, New Delhi., 1994
5. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002

6. John B Thomas, “An Introduction to Applied Probability and Random Processes”, John Wiley, 2000
7. Hillier F S and Liebermann G J, “Introduction to Operations Research”, 7th Edition, McGraw Hill, 2001
8. Simmons D M, “Non Linear Programming for Operations Research”, PHI, 1975

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Objectives:

1. To understand comparison of microcontrollers and digital signal processors
2. To learn and implement DSP programming
3. To understand internal details of DSP architecture, peripheral, addressing modes, interrupt structure, hardware multiplier

Course Outcomes:

1. Able to understand and use new /advanced DSP
2. Able to implement the basic power electronics control algorithm such as PWM techniques using DSPs.

Course contents:

Module No.	Course content	No. of Hrs
1	Review of microcontrollers and digital signal processors, architecture, peripheral modules.	**04**
2	Typical processors for control implementation, memory organization, CPU details.	**04**
3	Addressing modes interrupt structure, hardware multiplier, pipelining, Fixed- and floating-point data representations, Assemblers, linkers and loaders.	**06**
4	Binary file formats for processor executable files. Typical structure of timer-interrupt driven programs. Implementing digital processor based control systems for power electronics.	**06**
5	Reference frame transformations, PLL implementations, machine models, harmonic and reactive power compensation, space vector PWM.	**06**
6	Numerical integration methods. Comparison in terms of time step, stability	**04**
7	Multitasking concepts for power electronics implementations, The need for multitasking, various multitasking method	**04**

References

1. K. Ogata, "Discrete-Time Control Systems", second edition, Pearson Education Asia.
2. N. Mohan, "Power Electronics", third edition, John Wiley and Sons.

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Objective:

1. To know the causes and effects various power quality issues.
2. To understand effects of harmonics due to non-linear load
3. To learn mitigation methods for harmonics

Course Outcomes:

1. To identify the problems in power system due to harmonics
2. To suggest solutions to the problems in power quality issues.

Course contents:

Module No.	Course Content	No. of Hours
1	Introduction: Power Quality; Importance of power quality; Power Quality Evaluation; Terms and definitions of power quality issues as per IEEE std. 1159. Transients: Long-Duration Voltage Variations; Short-Duration Voltage Variations; Voltage Imbalance; Waveform Distortion; Voltage Fluctuation; Power Frequency Variations	**6**
2	Voltage Sags And Interruptions: Sources of Sags and Interruptions; Estimating Voltage Sag Performance; Fundamental Principles of Protection; Solutions at the End-User Level; Motor-Starting Sags; Utility System Fault-Clearing Issues	**6**
3	Transient Over voltages: Sources of Transient Overvoltage; Principles of Overvoltage Protection; Devices for Overvoltage Protection; Utility Capacitor-Switching Transients; Utility System Lightning Protection; Managing Ferro-resonance; Switching Transient Problems with Loads .	**6**
4	Fundamentals of Harmonics: Harmonic Distortion; Voltage versus Current Distortion; Harmonics versus Transients; Harmonic Indexes; Harmonic Sources from Commercial Loads; Harmonic Sources from Industrial Loads; Locating Harmonic Sources; System Response Characteristics; Effects of Harmonic Distortion; Inter harmonics.	**6**
5	Sinusoidal Supply: Power Factor Compensation-Linear circuits with Sinusoidal Supply Basic relationship, complex power, apparent power, power factor and power factor compensation. Non-Linear circuits with Sinusoidal Supply-Basic relationship, complex power, apparent power, power factor and power factor compensation.	**6**
6	Non- Sinusoidal Supply: Power Factor Compensation Linear circuits with non-Sinusoidal Supply-Basic relationship, complex power, apparent power, power factor and power factor compensation. Non-Linear circuits with non-Sinusoidal Supply-Basic relationship, complex power, apparent power, power factor and power factor compensation.	**6**
7	Power Quality Mitigation Techniques-Passive Filters; Shunt Active Filters; Series Active Filters; Unified Power Quality Compensators	**6**

Reference Book/Journals:

1. Roger C. Dugan, Mark F. McGranaghan and H. Wayne Beaty, ―Electrical Power System Quality, MCGraw Hill
2. G.T. Heydt , ―Electric Power Quality,‖ Stars in a Circle Publications
3. J. Arrillaga, N. R.Watson and S. Chen, ― Power System Quality Assessment, John Wiley & Sons
4. W. Shepherd and P. Zand, ― Energy flow and power factor in non-sinusoidal circuits Cambridge university press
5. IEEE-519: 1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
6. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Power Quality: Problems and Mitigation Techniques, John Wiley & Sons, First Edition 2015
7. Jos Arrillaga, B. C. Smith, Neville R Watson and A. R. Wood, ―Power System Harmonics Analysis‖ Wiley 1997
8. Math H. J. Bollen, ― Understanding Power Quality Problems,Voltage Sag and Interruptions Wiley-IEEE Press
9. IEEE Transactions on Power Systems
10. IEEE Transactions on Power Delivery
11. IEEE Transaction on Power Electronics

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Objective

The purpose of the course is

1) To introduce the nature of nonlinearities found in systems and control
2) To learn standard methods of analysis and design in nonlinear system.

Course Outcome:

Upon successful completion, a student should able to:

1) Understand and apply concepts of linear algebra for system analysis.
2) Understand mathematical models of various nonlinear systems.
3) Analyze performance of linear and nonlinear system and design controller.

Course Contents:

Module	Contents	Hrs.
1.	**Non-linear systems:** Introduction, behavior of non-linear system, common physical non linearity- saturation, friction, backlash, dead zone, relay, multi variable non-linearity.	04
2.	**Phase Plane Analysis:** Concept of phase plane, constructing phase portrait, Phase plane analysis of linear systems, Phase plane analysis of nonlinear systems, Existence of limit cycles.	07
3.	**Fundamentals of Lyapunov theory:** equilibrium points, concept of stability, linearization of nonlinear systems, Local stability, Lyapunov Equation, Lyapunov's direct method, Stability and instability theorems.	08
4.	System analysis based on Lyapunov's direct method and Control Design based on Lyapunov's direct method.	06
5.	**Describing Functions:** Stability analysis and limit cycles, Linear compensation methods, General describing functions of common nonlinearities, Relative stability.	05
6.	**Feedback linearization:** feedback linearization and canonical form, Input-state linearization, Input- output linearization.	05
7.	**Control design for nonlinear system:** Control design using linearized model, Lyapunov method of control design, control design using feedback linearization and back stepping.	07

Text/ Reference Books:

1. Slotine, J. E. & Weiping Li, Applied Nonlinear Control, Prentice-Hall, [1991]
2. Khalil, Hasan K., Nonlinear Systems, Macmillan Publishing, [1992]
3. Chi-Tsong Chen, "Linear Systems Theory and Design", Oxford University Press New York, 1999.
4. T. Kailath, "Linear Systems", Prentice-Hall, New Jersey, 1980, Science and Business Media 2008.
5. Gilbert Strang, " Linear Algebra and its Application", Fourth Edition CENGAGE Learning
6. Ogata, K., Modern Control Engineering, Prentice-Hall, [2002]
7. Gopal, M., Modern Control System Theory, John Wiley Eastern Ltd. New Delhi, [1984]
8. Friedland, B., Control System Design, McGraw-Hill, [1986]
9. Ogata, K., State Space Analysis of Control Systems, Prentice-Hall, [1967]
10. Kuo, B. C., Automatic Control Systems, Prentice-Hall, [1987]

SR.NO.	EXAMINATION	MODULE
1.	T1	1 , 2
2.	T2	3 , 4
3.	END SEMESTER	1 TO 7

Course Code: PL-MTPX201 Course: Power system dynamics and control Laboratory (AY 2019-20)

Course Objectives:

1. To study the stability considerations in power system.
2. To understand the different stability of power system and multi-machine stability concept
3. To study of voltage stability, PV, QV and PQ curves
4. To study of improving the stability of power system

Course Outcomes:

1. Able to understand and appreciate the stability concept in the power network.
2. Able to apply the effects of various electrical parameter on stability

Course Content:

Laboratory work to include at least Eight Simulations/Programmes based on every module.

Reference Books:

1. Kundur, P., "Power System Stability and Control", McGraw-Hill International Editions, 1994.

2. Anderson, P.M. and Fouad, A.A., "Power System Control and Stability", John Wiley, second edition 2003.

3. Van Cutsem, T. and Vournas, C., "Voltage Stability of Electric Power Systems", Springer

4. P. Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997.

5. K. R. Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.

Course Code: PL-MTPX202 Course: Advanced Control of Electrical Drives Laboratory (AY 2019-20)

Course Objectives:

1. To study the torque-speed characteristics of AC and DC drives and different types of load
2. To discuss modification of torque speed characteristics of AC and DC motors as per load requirements.
3. To understand the power modulators and control strategies
4. To study steady state stability of the motor load system and higher level control of ac drives.

Course Outcomes:

1. Able to apply the knowledge of electrical drives system for various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology.
2. Able to understand the basic requirements placed by mechanical systems on electric drives.
3. Able to apply the basic principles of power electronics in drives using switch-mode converters and pulse width modulation to synthesize the voltages in dc and ac motor drives.
4. Able to understand the need of modification of the torque speed characteristics of machines. Describe the operation of induction machines in steady state and dynamic condition.
5. Able to appreciate the speed control of induction motor drives in an energy efficient manner using power electronics with higher level control technique such as vector control.

Course Content:

Laboratory work to include at least Eight Matlab Simulations based on every module.

References:

1. G. K. Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Jersey, 1989.
2. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice- Hall of India Pvt. Ltd., New Delhi, 2003.
3. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2001.
4. B. K. Bose "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
5. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill Publishing company Ltd., New Delhi, 2002.

Course Code:PR-MTPX201 Course: Mini Project (AY 2019-20)

Course Objectives:

Students will be able to

1. To identify and understand relevant research work in Power electronics and power system sector
2. Analyse critically and evaluate technical solutions published in research papers
3. Develop innovative skill that enables for effective decision making and problem solving
4. Conduct original and empirical research

1. To formulate research problems based on research gap
2. Develop problem formulae to check current issues in Power sector industry
3. Apply analytical method , models to solve complex research problem

Course Code:AU-MTPX201 Course: Disaster Management (AY 2019-20)

Course objectives:

Students will be able to:

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. 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

Course contents:

Module No.	Course Content	Hours
1	Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	04
2	Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	04
3	Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.	04
4	Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	04
5	Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	04
6	Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India	04

Recommended Books:

1) R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.

2) Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.

3) Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi.

SR.NO.	EXAMINATION	MODULE
1.	T1	1 , 2
2.	T2	3 , 4
3.	END SEMESTER	1 TO 7

Course Code:AU-MTPX201 Course: Stress Management by Yoga (AY 2019-20)

Course Objective :

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcome:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Course contents:

Module No.	Course Content	Hours
1	Definitions of Eight parts of yog. (Ashtanga)	08
2	Yam and Niyam. Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	08
3	Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects-Types of pranayam	08

Recommended Books:

1) 'Yogic Asanas for Group Training-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur

2) "Raja yoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

SR.NO.	EXAMINATION	MODULE
1.	T1	1 , 2
2.	T2	3 , 4
3.	END SEMESTER	1 TO 7

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Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University) Andheri (W), Mumbai – 400058

COURSE CONTENTS

(M.Tech. in Power Electronics & Power System)

Semester III and IV

Academic Year: 2019-20

Course Code: PE-MTPX301 **Course:- Artificial Intelligence** **(AY 2019-20)**

Course Outcomes:

Students will demonstrate the ability to

1. Develop a basic understanding of AI building blocks presented in intelligent agents
2. Choose an appropriate problem solving method and knowledge representation technique
3. Analyse the strength and weaknesses of AI approaches to knowledge – intensive problem solving
4. Design models for reasoning with uncertainty as well as the use of unreliable information

Course content:

Module No	Course Content	Hours
1	**Introduction to Artificial Intelligence (AI)** History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Subareas of AI, Applications of AI, Current trends in AI	**04**
2	**Intelligent Agents** Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Age	**04**
3	**Problem solving 1** Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening(DFID), Informed Search Methods: Greedy best first Search ,A* Search , Memory bound edheuristic Search.	**07**
4	**Problem solving 2** Local Search Algorithms and Optimization Problems: Hill-climbing search Simulated annealing, Local beam search, Genetic algorithms. Adversarial Search: Games, Optimal strategies, The minimax algorithm, Alpha-Beta Pruning	**07**
5	Knowledge based Agents, The Wumpus World, The Propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining, Knowledge Engineering in First-Order Logic, Unification, Resolution, Introduction to logic programming (PROLOG), Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Inference in belief network.	**10**
6	**Planning and Learning** The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning, Learning: Forms of Learning, Inductive Learning, Learning Decision Tree, Expert System: Introduction, Phases in building Expert Systems, ES Architecture, ES vs Traditional System.	**06**
7	Applications Natural Language Processing (NLP), Expert Systems.	**04**

Text/Reference Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach “Second Edition" Pearson Education.
2. SarojKaushik “Artificial Intelligence” ,Cengage Learning.
3. George F Luger “Artificial Intelligence” Low Price Edition , Pearson Education., Fourth edition.
4. Ivan Bratko “PROLOG Programming for Artificial Intelligence”, Pearson Education, Third Edition.
5. Elaine Rich and Kevin Knight “Artificial Intelligence” Third Edition
6. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 1989.
7. Hagan, Demuth, Beale, “Neural Network Design” CENGAGE Learning, India Edition.
8. Patrick Henry Winston , “Artificial Intelligence”, Addison-Wesley, Third Edition.
9. Han Kamber, “Data Mining Concepts and Techniques”, Morgann Kaufmann Publishers.
10. N.P.Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press

Sr. No.	Examination	Module
1	Test I	1,2,part of 3
2	Test II	Part of 3,4,prt of 5
3	Final Examination	1 to 7

Course Code: PE-MTPX302 Course:- Optimization Techniques (AY 2019-20)

Course Outcomes:

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

- Understand importance of optimization
- Apply basic concepts of mathematics to formulate an optimization problem

  Analyse and appreciate variety of performance measures for various optimization problems

Course content:

Module No	Course Content	Hours
1	Introduction to Classical Methods & Linear Programming Problems Terminology, Design Variables, Constraints, Objective Function, Problem Formulation. Calculus method, Kuhn Tucker conditions, Method of Multipliers	06
2	Linear Programming Problem, Simplex method, Two-phase method, Big-M method, duality, Integer linear Programming, Dynamic Programming, Sensitivity analysis..	06
3	Single Variable Optimization Problems: Optimality Criterion, Bracketing Methods, Region Elimination Methods, Interval Halving Method, Fibonacci Search Method, Golden Section Method. Gradient Based Methods: Newton-Raphson Method, Bisection Method, Secant Method, Cubic search method.	06
4	Multi Variable and Constrained Optimization Technique, Optimality criteria , Direct search Method, Simplex search methods, Hooke-Jeeve‘s pattern search method, Powell‘s conjugate direction method, Gradient based method, Cauchy‘s Steepest descent method, Newton‘s method , Conjugate gradient method. Kuhn - Tucker conditions, Penalty Function, Concept of Lagrangian multiplier, Complex search method, Random search method	06
5	Intelligent Optimization Techniques: Introduction to Intelligent Optimization, Soft Computing, Genetic Algorithm: Types of reproduction operators, crossover & mutation, Simulated Annealing Algorithm, Particle Swarm Optimization (PSO) - Graph Grammer Approach – Example Problems	06
6	Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP	06

References

- S. S. Rao, “Engineering Optimisation: Theory and Practice”, Wiley, 2008.
- K. Deb, “Optimization for Engineering design algorithms and Examples”, Prentice Hall, 2005.
- C.J. Ray, “Optimum Design of Mechanical Elements”, Wiley, 2007.
- R. Saravanan, “Manufacturing Optimization through Intelligent Techniques, Taylor & Francis Publications, 2006.
- D. E. Goldberg, “Genetic algorithms in Search, Optimization, and Machine learning”, Addison-Wesley Longman Publishing, 1989.

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PE-MTPX303 Course: Electric Vehicle Technology (AY 2019-20)

Course Objectives

- Know the history of electric hybrid electric vehicles (EV & HEV) and emphasize the need and importance of EV-HEV for sustainable future.
- Introduce the fundamental concepts and principles of electric and hybrid electric vehicles drive train topologies
- Develop a thorough understanding of the key elements of EV/HEV: Electric Machines for Propulsion Applications and Energy Sources
- Model, analyse and design electric and hybrid electric vehicles drive train and to understand energy management strategies

Course Outcomes

Students will be able

- To identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future.
- To identify and describe the principles of various EV/HEVs drive train topologies along with their power flow control and fuel efficiency estimation.
- To design and select electric propulsion system components for EV/HEV drives suitability for the desirable performance and control**.**
- To compare and evaluate various energy sources and energy storage components for EV and HEV applications.
- To model, analyze and design EV/HEV drive train with energy management strategies**.**
- To recognize the need to adapt and engage in operations EV/HEV with the absolute technological change in the transportation system for sustainable future.

Module	Contents	Hours
1	**Introduction:** Basics of vehicles mechanisms**,** history of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV, Power/Energy supplies requirements for EV/HEV applications, vehicle power source characterization, and transmission characteristics.	06
2	**Drive-train Topologies:** Review of electric traction, various electric drive-train topologies, basics of hybrid traction system, various hybrid drive-train topologies, power flow control in drive-train topologies, fuel efficiency analysis.	06
3	**DC and AC Machines for Propulsion Applications:** Electric system components for EV/HEV, suitability of DC and AC machines for EV/HEV applications, AC and DC Motor drives. Advanced permanent magnet and switch reluctance machines, configuration and control of drives.	06
4	**Energy Sources for EV/HEV:** Requirements of energy supplies and storage in EV/HEV, Review of batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV, characteristics and comparison of energy sources for EV/HEV, hybridization of different energy sources.	08
5	**Modelling and design of the drive trains:** Modelling and analysis of EV/HEV drive train, sizing of motor, and design of traction power electronics, various vehicle subsystems.	08
6	**Energy Management Strategies and Energy Efficiency:** EV/HEV energy management strategies, classification and comparison of various energy management strategies, energy efficiency comparison for various EV and HEV variants	08

Reference Books:

1. I. Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
2. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press. 2005
3. Sheldon Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, Springer 2013
4. J. Larminie and J. Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003
5. C. MI, M. Abul and D. W. Gao, *Hybrid Electrical Vehicle Principles and Application with Practical Perspectives*, Wiley 2011
6. Robert A. Huggins, *Energy Storage*, Springer 2010
7. N. Mohan, T.M.Undeland, W.P Robbins, *Power Electronics, Converters, Applications & Design*, Wiley India Pvt. Ltd., 2003
8. B. K Bose, *Modern Power Electronics and AC Drives*, Pearson Education 2002

Website Reference:

http://nptel.iitm.ac.in: Introduction to Hybrid and Electric Vehicles - Web course

Sr. No.	Examination	Module
1	Test I	1,2
2	Test II	3,4
3	Final Examination	1 to 7

Course Code: PE-MTPX304 Course: Advance Course on Smart AC-Drives **(AY 2019-20)**

Course Objective:

Ramp-up the students from Drive-Basics to Drives-Communication through PRACTICALS on latest Industrial Grade Digital AC-Drives & latest series of Industrial PLC, with networking concepts. Making participants familiar/work with SIMATIC S7-1200 with STEP 7 V14, various communication with S7-1200 like Modbus TCP/IP, G120 Integration.

Pre-requisite:

The students should refer to the given Web-based training links and required to come prepared for the training.

Course Outcome:

Industry ready Engineers confident to operate on Drive-PLC combination/ communication

Module No.	Course Contents	Hrs
1	Brief Basic on Power Electronics: (Thyristors, Power transistor, IGBTs, IGCT) AC Motor Basics: Construction , principle of operation, T-N characteristics AC Drives Basics : Block diagram, 1Q-4Q principle of operation , working principal	06
2	Control Unit CU: Different types of control unit ,Selection of control unit, Different types of input/output to control unit, Wiring of inputs/output Power Module PM : Different types of control unit, Selection of power unit Different types of input supply to Power module, Wiring of input & output	06
3	Parameterization by using: BOP, AOP, Starter Data backup by using: BOP, AOP, Starter, Memory card Setpoint channel : Different types of speed setpoint, Setpoint processing, Ramp function generator	08
4	Control modes: Open loop (V/F), Closed loop (Vector control)	04
5	Communication with PLC: Basics of Drive PLC communication, Communication integration, Parameterization Diagnostics by using: Control unit LED , Power module testing , BOP, AOP, Starter, Trace	06

6	Automation and Networking System Overview: Introduction of S7 1200 Hardware , communication ports on CPU, LEDs on CPU, different I/O modules involved, wiring of digital and analog modules, introduction to STEP 7 V15 software, project view and portal view, creating a project in software and hardware. PLC Tags, Programming Blocks: ➢ Addressing concepts on Input, Output, Memory, Timers and Counters ➢ Check for 0, check for 1 concepts, designing AND/OR logic in PLC ➢ LAD, FBD, STL programming overview ➢ PII, PIQ, RLO concepts, different registers in CPU ➢ SET RESET instructions, SR/RS blocks, logic designing and hands-on practice ➢ Comparators, mathematical operators in library and practice ➢ Different types of timers and logics, different types of counters and logics ➢ Linear programming and structured programming ➢ Different blocks involved in structured programming and introduction of blocks ➢ Creating FC, FB and DB ➢ Different types of Data blocks and their creation, usage in logic ➢ Different types of Organizational blocks and their importance ➢ Logics designing and creation of OB's ➢ Optimization of data block concepts Types of faults and CPU behavior ➢ Functional faults: tools to detect functional faults, cross reference Reference data, Archive/Retrieve ➢ Force, Rewiring, Compare blocks, Protection of Block, Assignment list, unused symbols ➢ Symbol table, Watch table, Force table ➢ System faults: LED's status, error OBs involved ➢ Traces- creation and observation, Slicing concept Enabling Web server ➢ Checking PLC status on internet, diagnostics buffer, Watch table ➢ Changes the status of PLC from RUN/STOP and vice versa, all from web server ➢ Different types of Sensors, wiring details and analog concept ➢ Scaling and non-scaling concept ➢ Blocks involved in analog communication ➢ Closed loop concept ➢ PID concept, software blocks involved Profinet concept, features, speed and devices to be connected ➢ Automation System to another Automation System communication on PN ➢ Concept and blocks involved, data transfer with settings ➢ MODBUS concept, registers involved, MODBUS TCP Communication ➢ Communication blocks involved, programming and settings ➢ Data transfer through MODBUS protocol ➢ Concept of I-device ➢ Configuration between 2 CPU's and settings ➢ Configuration between CPU and 2 Remote stations ➢ Importance of Media redundancy protocol ➢ PLC HMI communication establishment on PN ➢ Creating connection, Screen designing, HMI tags ➢ Digital tags and Analog tags ➢ WEB Server, WEB pages	08

7	Automation and Networking Design and principle of operation of the SINAMICS G120 inverter ➢ Drive theory ➢ PLC-Drive communication configuration ➢ Programming of Drive through V15 Software ➢ G120 integration with PLC ➢ Diagnostics tools in TIA Portal Software	04

Contents for Hands-on Training:

- Commissioning by using BOP , AOP , Starter
- Data Back-up by using BOP , AOP, Starter
- Configuration of different Set point channels
- Response at motor end by different RFG Configuration
- Response of Motor and Drive in V/F Linear, V/F Parabolic Mode & Sensor less Vector Control Mode
- Controlling of Drive from PLC
- Diagnostics of Drive by using control unit LED, BOP, AOP, Starter and trace functions.
- Hardware checking of Power Module in Power OFF Condition and simulation mode.

- Creating a project in software, hardware configuration.
- Creating, Programming and Introduction to different blocks.
- Logics designing and creation of OB's.
- Force, Rewiring, Compare blocks, Protection of Block, Assignment list, unused symbols.
- Checking PLC status on internet, diagnostics buffer, Watch table.
- PID concept, software blocks involved and blocks involved in analog communication.
- Configuration between 2 CPU's and settings.
- Creating connection, Screen designing, HMI tags
- Data transfer through MODBUS protocol.
- Drive Integration with PLC.

Sr. No.	Examination	Module
1	Test I	1,2,3
2	Test II	4,5
3	Final Examination	1 to 7

Course Code: OE-MTPX301 Course:- Business Analytics AY 2019-20

Course Objectives:

- Student will be able to have a comprehensive understanding of business analytics methods

Course Content:

Sr.No.	Description	Hrs
1	Business Analysis: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst. Stakeholders: the project team, management, and the front line, Handling Stakeholder Conflicts.	07
2	Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.	08
3	Forming Requirements: Overview of Requirements, Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.	09
4	Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modelling, Business Process Modelling	10
5	Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements. Managing Requirements Assets: Change Control, Requirements Tools	10
6	Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.	04

Reference:

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

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 6

Course Code: OE-MTPX302 Course:- Industrial Safety (AY 2019-20)

Course Content:

Sr.No.	Description	Hrs
1	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.	
2	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.	
3	Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	
4	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.	
5	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:

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

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 5

Course Code: OE-MTPX303 Course:- Operational Research AY2019-20

Course Outcomes:

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

Course Content:

Sr.No.	Description	Hrs
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models	
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming	
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.	
4	Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.	
5	Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 5

Course Code: OE-MTPX304 Course:- Cost Management of Engineering project (AY 2019-20)

Course Content:

Sr.No.	Description	Hrs
1	Introduction and Overview of the Strategic Cost Management Process	
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.	
3	Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	
4	Cost Behviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	
5	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	

References:

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

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 5

Course Code: OE-MTPX305 Course:- Waste to Energy (AY 2019-20)

Course Outcomes:

At the end of the course students will be able to

1. Classify waste from energy recovery point of view
2. Know biomass pyrolysis and gasification
3. Understand biomass combustion
4. Understand working of biogas plant and importance of biomass energy programme in India

Course Content:

Module no.	Contents	Hrs
1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digesters	6
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	6
3	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	6
4	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.	6
5	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	6
6	Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion	6
7	Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	6

References:

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

Sr. No.	Examination	Module
1	T-1	Module 1 and 2
2	T-2	Module 3 and 4
3	Final Examination	Module 1 to 5

Dissertation Stage –I

Course Code: PR-MTPX301 Seminar on Literature Review (AY 2019-20)

Course Outcomes:

1. Student will be able to search literature related to the project topic
2. Student will be able to analyse finding of literature review
3. Student will be able to identify research gap
4. Student will be able to integrate the knowledge to define the problem statement appropriately
5. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques

Course content:

Sr. No.	Description	Hrs.
1	The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a report for evaluation. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report.	**48**

Course Code: PR-MTPX302 Seminar Stage I (AY 2019-20)

Course Outcomes:

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
3. Student will be able to use knowledge for formulation / fabrication of the desired project
4. Student will be able to analyse the available resources and to select most appropriate one

Course content:

Sr.no.	Description
1	Student shall finalize a theme, related to mechanical engineering (design engineering area) for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report.

Guidelines for Dissertation

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

Dissertation I should be assessed based on following points

1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope

SEM – IV
Dissertation Stage –II

Course Code: PR-MTPX401 Seminar (Pre –Synopsis) (AY 2019-20)

Course Outcomes:

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
3. Student will be able to use knowledge for execution of the desired project and validation of the results obtained
4. Student will be able to analyse the experimental data/ findings

Course content:

Sr.no.	Description	Hrs.
1	Student shall study the problem of dissertation in the light of outcome of Stage I and Stage II seminars. On completion of data collection, analysis, and inferencing, the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis.	**48**

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points

1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization or current Research / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

Course Code: PR-MTPX402 Dissertation and Viva Voce (AY 2019-20)

Course Outcomes:

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
3. Student will be able to use knowledge for formulation / fabrication of the desired project
4. Student will be able to analyse the experimental data/ findings and discuss the merits and limitations of the project work

Course content:

Sr.no.	Description
1	On finalization of the dissertation student shall submit the dissertation report. The student shall have to appear for a Viva-voce examination for the dissertation.