SIR PADAMPAT SINGHANIA UNIVERSITY

Udaipur

SCHOOL OF ENGINEERING

Course Curriculum of 2-Year M.Tech. Degree Programme in Electrical Engineering (Specialization in Energy & Power System)

(Batch: 2018-20)

Credit Structure

M.Tech. Core		M.Tech. Elective	
Category	**Credits**	**Category**	**Credits**
Departmental Core Subjects	51	Departmental Electives	6
Humanities & Basic Sciences Subjects	3		
Total	54	Total	6
		Grand Total	60

Distribution of Total Credits & Contact Hours in all Semesters

S. No.	Semester Number	Credits/Semester	Contact hours/week
1	I	16	17
2	II	17	18
3	III	15	20
4	IV	12	18
	Total	60	--

Course Structure: M.Tech. 2018-20

Semester-I

Sr. No.	Course Code	Course Title	L	T	P	Credit(s)
1	EE-551	Power Transmission Systems	3	1	0	4
2	EE-552	Non-Conventional Electrical Energy Systems	3	0	0	3
3	EE-554	Power System Simulation Lab	0	1	1	2
4	EE-555	Artificial Intelligence application to Power Systems	3	1	0	4
5	MA-555	Advanced Engineering Mathematics	3	0	0	3
					Total Credits	16
					Total Contact hours/week	17

Semester-II

S. No.	Course Code	Course Title	L	T	P	Credit(s)
1	EE-556	Power System Control & Stability	3	1	0	4
2	EE-557	Solar Energy Technology	3	1	0	4
3	EE-558	Computer Methods in Power System Analysis	3	1	0	4
4	EE-559	Power & Energy System Lab	0	1	1	2
5	EE-560	High Voltage Technology	3	0	0	3
					Total Credit	17
					Total Contact hours/week	18

Semester-III

S. No.	Course Code	Course Title	L	T	P	Credit(s)

1	EE-570	Power System Instrumentation	3	1	0	4
2	EE-5XX	Departmental Elective – I	3	0	0	3
3	EE-5XX	Departmental Elective – II	3	0	0	3
4	EE-580A	Dissertation – I	0	0	5	5
					Total Credits	15
					Total Contact hours/week	20

Semester-IV

S.No.	Course Code	Course Title	L	T	P	Credit(s)
1	EE-580B	Dissertation – II	0	0	9	9
2	EE-580C	Dissertation Viva Voce	0	0	0	3
					Total Credits	12
					Total Contact hours/week	18

List of Departmental Elective - I

S.No.	Course Code	Course Title	L	T	P	Credit(s)
1	EE-571	Power Quality & Reliability	3	0	0	3
2	EE-572	Energy Management Systems & SCADA	3	0	0	3

List of Departmental Elective - II

S.No.	Course Code	Course Title	L	T	P	Credit(s)
1	EE- 573	Neural Networks	3	0	0	3
2	EE- 575	Smart Grid	3	0	0	3
3	EE-576	Knowledge Based Systems in Power Engineering	3	0	0	3

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Semester - I

(Departmental Core Subject)

EE-551 L-T-P-C
Power Transmission System 3-1-0-4

Objective: *The subject deals with the transmission of power over high voltage AC & DC lines & converter analysis.*

Course Content

Transmission line Trends & preliminaries, Corona effects - Power loss & audible noise, Radio interference. Electrostatic field of EHV lines. General comparison of A.C. & DC transmission, AC DC converters & components, control & protection for HVDC systems. Reactive power management, Integrated AC-DC systems. Multi-terminal D.C transmission. Flexible AC transmission systems-concept & devices.

Text/Reference Books

1. HVDC Power Transmission Systems. Padiyar K.R. 2nd Ed. Willey Eastern Limited. 2010.
2. Direct Current Transmission. Kimbark E.W. Wiley-Interscience. 1971.

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Semester - I

(Departmental Core Subject)

EE-552 L-T-P-C
Non-Conventional Electrical Energy Systems 3-0-0-3

Objective: *The subject deals with the types, performance characteristics & applications of non renewable resources.*

Course Content

Non renewable reserves & resources; renewable resources, Transformation of Energy. Solar Power: Solar processes & spectral composition of solar radiation; Radiation flux at the Earth's surface. Solar collectors types & performance characteristics, applications. Wind Power: Wind speed, conversion & converters; conversion to electrical power. Characteristics of wind power plant, applications. Tidal Power: Wave characteristics. Conversion systems & their performance features. Application, Geothermal Power: Biological conversion of Energy.

Text/Reference Books

1. Non-conventional resources of energy. Sawhney G. S. Prentice Hall India. 2012
2. Non-Conventional Energy Sources and Utilization (Energy Engineering). Rajput R. K. 2nd Ed. S. Chand. 2012.

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Semester - I

(Departmental Core Subject)

EE-554 L-T-P-C
Power System Simulation Lab 0-1-1-2

Objective: *In this course, students will be given problems based on power system parameter associated design & according to that power system simulation is executed.*

List of Experiments

1. Gauss-Seidal load flow analysis
2. Newton-Raphson method of load flow analysis
3. Fast decoupled load flow analysis
4. Fault analysis using software
5. Economic dispatch using software

Text/Reference Books

1. Manual for power system simulation.

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Semester - I

(Departmental Core Subject)

EE-555 L-T-P-C
Artificial Intelligence Application to Power Systems 3-1-0-4

Objective: *The subject deals with the expert systems in power system monitoring operation & control using artificial intelligence.*

Course Content

Introduction to artificial intelligence. Use of expert systems in power system monitoring operation & control. Expert systems in fault diagnosis. Applications of Neural network based power system estimators & controllers. Fuzzy logic based controllers. Alarm analysis & decision making processes. Applications of imaging & pattern recognition for system identification & control. Database management & computer graphics aided decision making processes. Artificial intelligence method of crisis control & restoration processes. Application of GA in power system problem solution.

Text/Reference Books

1. Artificial Intelligence Techniques in Power Systems. Warwick K. Institution of Electrical Engineers.1997
2. Introduction to Artificial Intelligence. Goswami Gunjan. 3rd Ed. S.K. Kataria and Sons.2014.

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Semester - I

(Humanities & Basic Sciences Subjects)

MA - 555 L-T-P-C
Advanced Engineering Mathematics 3-0-0-3

Objective: *In this course certain advanced numerical techniques with probability & statistics will be discussed. These concepts play important role in mechanical & electrical engineering.*

Course Content

Vector & Tensor analysis in Cartesian system, effect of rotation of coordinate systems. Review of ODEs; Laplace & Fouriers methods, series solutions & orthogonal polynomials. Sturm-Liouville problem. Review of 1^{st} & 2^{nd} order PDE's.

Linear system of algebraic equations. Gauss elimination, LU decomposition etc., Matrix inversion, ill-conditioned systems. Numerical eigen solution techniques (Power, Householder, QR methods etc.). Numerical solution of systems of nonlinear algebraic equations; Newton-Raphson method. Numerical integration: Newton-Cotes methods, error estimates, Gaussian quadrature. Numerical solution of ODE's: Euler, Adams, Runge-Kutta methods & predictor-corrector procedures; stability of solutions; solution of stiff equations. Solution of PDEs: finite difference techniques.

Probability & Statistics – Probability Distribution, Bayes theorem, Parameter Estimation, Testing of Hypothesis & Goodness of Fit.

Text/Reference Books

1. Advanced Engineering Mathematics. Kreyszig E. 10^{th} Ed. Wiley Eastern. 2012.
2. Numerical Methods for Scientific and Engineering Computation.Jain M.K.,Iyengar S. R. K. & Jain R. K. 3^{rd} Ed. New Age International 1993.

3. Computational Methods for Partial Differential Equations. Jain M.K., Iyenger S.R.K. & Jain R.K. New Age International. 1994
4. Methods of Mathematical Physics. Courant R. & Hilbert D. Wiley. 1989.
5. Mathematical Methods for Physicists. Arfken G. B. & Weber H. J. 6th Ed. Academic Press.2005.

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Semester - II

(Departmental Core Subject)

EE-556 L-T-P-C
Power System Control and Stability 3-1-0-4

Objective: *The subject deals with the problems in power systems stability, excitation systems & methods of improving stability.*

Course Content

Introduction to Power Systems Stability Problem: Rotor Angle, Voltage Stability, Mid-term & Long-term Stability, Classification of Stability – Synchronous machine modeling – Representation in stability – Load representation – Excitation Systems – Prime mover & Energy Supply systems – Small Signal Stability: Fundamental concepts, state space representation, Eigen properties, Single machine infinite bus systems, Power Systems Stabilizer (PSS), Multi machine systems – Transient Stability: Fundamentals of TS, Numerical Integration methods, Simulation of power system dynamic response, analysis of unbalanced faults, protective relaying Direct method of transient, stability, Transient Energy Function (TEF) Approach Voltage Stability: Basic Concepts, Voltage Collapse, Classification of Voltage Stability – Voltage Stability Analysis Modeling, static & dynamic analysis, continuation power flow analysis, prevention of voltage collapse, Impact of network switching disturbances – Mid-Term & Long-Term Stability Classification between mid-term & long-term & long-term stability, response of power plants following large disturbances, Simulation of long term dynamic response modeling requirement material integration techniques – Methods of Improving Stability: Small Signal Stability enhancement, power systern stabilizers, SVC.

Text/Reference Books

1. Power System Stability and Control. Kundur Prabhat. Mc-Graw Hill Inc. 1994..
2. Electrical Power Systems. Wadhwa C. L. 6th Ed. New Age International Publishers.2012.

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Semester - II

(Departmental Core Subject)

EE-557 L-T-P-C
Solar Energy Technology 3-1-0-4

Objective: *The subject deals with the design methods, components, simulations & performance analysis of solar energy systems.*

Course Content

Solar Energy Technology Current alternate energy sources-thermodynamic view point & conversion methods. Components of solar energy systems, collector performance. Radiation & meteorological data processing, long term conversion factors. System configurations & system performance prediction. Simulations, design methods. System design & optimization. Solar thermal systems applications to power generation, heating & cooling. Solar passive devices: solar stills, ponds, greenhouse, dryers. Trombe wall overhangs & winged walls. Wind energy conversion systems. Economics of solar & wind energy systems.

Text/Reference Books

1. Solar cells: Operating Principles, Technology and System Application. Green Martin Prentice Hall Inc.1982.
2. Physics of Solar Cell. Wurfel Peter. Wiley.2005.
3. Solar Engineering of Thermal Process. Duffiee & Backman. John Wiley.1991.
4. Solar Energy- Principle of Thermal Collection and Storage. Sukhatme S.P. & Nayak J.K..2nd Ed. Mcgraw Hill.2006.

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Semester - II

(Departmental Core Subject)

EE-558 L-T-P-C
Computer Methods in Power System Analysis 3-1-0-4

Objective: *The subject deals with different methods used for load flow studies, fault analysis in power system.*

Course Content

Review of network matrices - Bus admittance & impedance matrices - Sparse matrix techniques - Symmetrical & unsymmetrical faults - Short circuit studies using matrix methods - Review of load flow studies Decoupled & approximate methods - Optimum generation scheduling with & without losses - General power system optimization problems - Power system stability analysis - Synchronous machines - Voltage regulator & turbine governor models - Transient stability analysis solution methods – Multi machine systems.

Text/Reference Books

1. Computer Techniques and Models in Power Systems. Rao K.U. I. K.International Pvt. Ltd. 2007.
2. Computer Techniques in Power System Analysis. Pai M.A. 2nd Ed. Tata McGraw-Hill Education. 2005

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Semester - II

(Departmental Core Subject)

EE-559 L-T-P-C
Power & Energy System Lab 0-1-1-2

Objective: *In this course, student will be given some problems based on Power & Energy consumption & optimization. According to that student will solve the problem & execute the program.*

List of Experiments

1. Load flow analysis of two-bus system with STATCOM
2. Transient analysis of two-bus system with STATCOM
3. Calculating the available transfer capability of a system using an existing load flow program
4. Computation of harmonic indices generated by a rectifier feeding a R-L load
5. Analysis of Induction motor starting
6. Analysis of variable speed wind energy conversion system- DFIG
7. Analysis of variable speed wind energy conversion system- PMSG
8. Designing of active filter for mitigating harmonics

Text/Reference Books

1. Dynamic Simulation of Electric Machinery, Chee-Mun Ong. Prentice Hall. 1998.
2. Software Manual.

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Semester - II

(Departmental Core Subject)

EE-560 L-T-P-C
High Voltage Technology 3-0-0-3

Objective: *The subject deals with the importance, generation, measurement & testing of high AC & DC voltages & currents.*

Course Content

Importance of high voltages & IIV tests – Generation of high AC, DC & impulse Voltages & currents – Measurement of AC, DC & impulse voltages & currents – IIV testing techniques – General requirements of IIV testing – Testing of internal & external internal systems – Nondestructive testing.

Text/Reference Books

1. High Voltage Engineering . Naidu M.S. & Kamaraju. 5th Ed. McGraw Hill. 2013.
2. High Voltage Engineering. Wadhwa C.L. New Age International Private Ltd.1995.

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Semester - III

(Departmental Core Subject)

EE-570 L-T-P-C
Power System Instrumentation 3-1-0-4

Objective: *The subject deals with the electrical instruments & measuring techniques including microprocessor based systems.*

Course Content

General scope of instrumentation in power systems. Electrical instruments & meters. Telemetry. Data transmission channels-pilots, PLCC, Microwave links. Interference effect. Automatic meter reading & billing. Simulators. SCADA & operating systems. Data loggers & data display system. Remote control instrumentation. Disturbance recorders. Area & Central Control station instrumentation. Frontiers of future power system instrumentation including microprocessor based systems. Application of digital computers for data processing & on-line system control.

Text/Reference Books

1. Instrumentation, Measurement, and Analysis. Nakra D. C. & Chowdhury K. K. 2nd Ed. Tata McGraw Hill.2007.
2. Modern Electronic Instrumentation and Measuring Techniques. Helfrick & Cooper. Prentice Hall India. 1986.

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Semester - III

(Departmental Core Subject)

EE-580A L-T-P-C
Dissertation Stage - I 0-0-5-5

The Dissertation for M.Tech programme consists of two parts: Dissertation-I and Dissertation-II. Dissertation-I is undertaken during the III Semester.

The Dissertation is by far the most important single piece of work in the post-graduate programme. It provides the opportunity for student to demonstrate independence and originality, to plan and organize a large Dissertation over a long period and to put into practice some of the techniques students have been taught in the course. Students will choose a dissertation, in consultation with a faculty member, who will act as the Supervisor. Dissertation involves a combination of sound background research, a solid implementation, or piece of theoretical work, and a thorough evaluation of the dissertation's output in both absolute and relative terms. The very best dissertations invariably covers some new ground, e.g. by developing a complex application which does not already exit, or by enhancing some existing application or method to improve its functionality, performance etc.

The student will prepare the Dissertation report as per the prescribed format/guidelines, and present the same as a seminar at the end of the semester.

The Dissertation will be evaluated continuously over the span of the III Semesters, as per the approved procedure.

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Semester - IV

(Departmental Core Subject)

EE-580B	L-T-P-C
Dissertation Stage - II	0-0-9-9

After completion of Dissertation-I, students will undertake the Dissertation-II in the IV Semester. The idea conceived and progress made in the Dissertation-I shall be extended as Dissertation-II under the supervision of a faculty member. Students shall complete the theoretical and practical aspect of the project. Thereafter they will prepare a report, as per the prescribed format/ guidelines, incorporating the results, their analysis and interpretation. The report, duly certified by the Supervisor, should be submitted to the Head of the Department. The report should also be presented as a seminar at the end of the semester.

Progress made by the student will be continuously monitored throughout the semester and evaluated as per the approved procedure.

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Semester - IV

(Departmental Core Subject)

EE-580C	L-T-P-C
Dissertation Viva Voce	0-0-0-3

Dissertation Viva Voce is the verbal defense of the dissertation carried out by the student in front of a panel of examiners. The objective of Viva Voce examination is to confirm that the piece of work submitted as a dissertation is student's own work, he/she has a sound understanding of the subject of the dissertation, aware of the recent works in the area of dissertation, methodology adopted, and importance/relevance/merits of the output in relation with the existing results in the area.

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Semester - III

(Departmental Elective - I)

EE-571 L-T-P-C
Power Quality and Reliability 3-0-0-3

Objective: *The subject deals with the power quality & voltage quality standards, interruptions & transmission system reliability evaluation & analysis.*

Course Content

Overview of power quality – Power quality & voltage quality, introduction to EMC standards – short & long interruptions – reliability evaluation – Voltage sags – Characterization – Equipment behavior – Voltage – Sags – Stochastic assessment – Mitigation of Interruptions & Voltage sags – Basic Probability Theory: Review of probability concepts – Probability distributions – Applications of binomial distribution to engineering problems – Probability distribution in reliability evaluation – Network modeling & evaluation of simple & complex systems – system reliability evaluation using probability distributions – Frequency & duration techniques – Generation System. Reliability Evaluation: Concept of LOLP & E(DNS): Evaluation of these indices for isolated systems – Generation system – Reliability analysis using the frequency & duration techniques – Transmission System Reliability Evaluation: Evaluation of the LOLP & E(DNS) indices for an isolated transmission system – Distribution System Reliability Evaluation: Reliability analysis of radial systems with perfect & imperfect switching.

Text/Reference Books

1. Power Quality in Electrical Systems. Kusko Alexander & Thompson Marc T. Tata Mcgraw Hill.2007.

2. Reliability Engineering. Amendola & Bustamante. Kluwer Academic Publishers.1988.

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Semester - III

(Departmental Elective - I)

EE-572 L-T-P-C
Energy Management Systems and SCADA 3-0-0-3

Objective: *The subject deals with the energy production, Cost models, budgeting & planning with practical considerations.*

Course Content

Characteristics of power generating units – Steam, hydro & Nuclear – Unit commitment, Spinning Reserve – Thermal, hydro & fuel constraints solution techniques – Generation schedule with limited energy supply hydro thermal scheduling, energy production – Cost models, budgeting & planning – practical considerations – Interchange considerations Interchange evaluation for regional operations Power Pools – Types of interchanges Exchange costing techniques – Busies ideas of energy management centers & their functions. Network analysis program in EMS.

Text/Reference Books

1. SCADA and Energy Management System. Bisht T. K. 1st Ed. S.K. Kataria & Sons. 2013.

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Semester - III

(Departmental Elective - II)

EE-573 L-T-P-C
Neural Networks 3-0-0-3

Objective: *The subject deals with the concepts of neural network with issues related to architecture, training, testing & data preparation.*

Course Content

Introduction: Elementary neurophysiology - From neurons to ANNs - Neuron model. Feedforward networks: perception - training rule -limitations; multiplayer perceptron – back propagation algorithm - issues related to architecture, training, testing & data preparation; Recurrent networks: Hopfield network - as an associative memory - Hebb's rule for storage - memory capacity - limitations; Extensions of Hopfield network - real, complex, stochastic, models, sequential storage; Unsupervised learning models: Hebbian learning, competitive learning. Hebbian learning - Principal Components Analysis, Oja's rule, Sanger's rule, Linsker's studies. Competitive learning - k-means clustering, scale-based clustering, Adaptive Resonance Theory, (ART), Learning Vector Quantization-Self - organizing map-Applications.

Text/Reference Books

1. Introduction to Neural Networks. Sivanandam S. N., Sumathi S. & Deepa S. N. 1st Ed. McGraw Hill. 2005.
2. Introduction to Artificial Neural System. Zurada J. M. 1st Ed. Jaico Publisher. 1994.

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Semester - III

(Departmental Elective - II)

EE-575 L-T-P-C
Smart Grid 3-0-0-3

Objective: *The subject deals with evolution, concept, need & technologies used for smart grid.*

Course Content

Introduction to Smart Grid: Evolution of Electric Grid, Concept, Definitions & Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges & benefits Difference between conventional & Smart Grid, Concept of Resilient &Self-Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts & global Smart Grid initiatives. Smart Grid Technologies: Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS & HVDC, Wide area monitoring, Protection & Control.

Text/Reference Books

1. Smart Grid Fundamental of Design and Analysis. Momoh J. 2nd Ed. Wiley. 2012.
2. Smart Grid Technology and Applications. Yokoyama A., Ekanayake J., Wu J., Liyanage K. & Jenkins N. 1st Ed. Wiley. 2012.

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Semester - III

(Departmental Elective - II)

EE-576 L-T-P-C
Knowledge Based Systems in Power Engineering 3-0-0-3

Objective: *The subject deals with the introduction, types & characteristics of knowledge based systems. Power system applications of knowledge based systems.*

Course Content

Characterization of power system problems – Drawbacks & limitations of conventional approaches – Introduction to knowledge based systems – Types & characteristics of knowledge based systems: Artificial Intelligence, Expert Systems, Artificial Neural networks, Pattern recognition, Machine Learning, Fuzzy systems, Genetic Algorithms & Evolutionary Programming, Simulated Anneling, Data Mining, Hybrid Methods – Classification of Power System problems for use of knowledge based systems – Power system applications of KBS: Planning, Operation & Control – Fault Diagnosis & Alarm processing – Load forecasting – Generator scheduling – Unit Commitment & Economic Dispatch.

Text/Reference Books

1. Intelligent knowledge based systems in electrical power engineering. McDonald J. R., McArthur S., Burt G. & Zielinski J. 1st Ed. Springer. 1997.