Department of Electrical and Computer Science Engineering

Course curriculum of M. Tech Electrical Infrastructure

Semester – I

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
EE195001	Special Electrical Machines	3	0	3	4.5
EE195002	Power Electronic Converters Operation Design and Control	3	0	3	4.5
EE5001	Renewable Energy Infrastructure	3	0	0	3
	Elective- I	3	0	0	3
	Elective- II	3	0	0	3
	Total	**15**	**0**	**6**	**18**

Department of Electrical and Computer Science Engineering

Course curriculum of M. Tech Electrical Infrastructure

Semester – II

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credits
EE195007	Power Transmission and Distribution Systems	3	0	0	3
EE195010	Microgrid	3	0	3	4.5
HS225003	Research Methodology	3	1	0	4
	Department Elective- III	3	0	0	3
	Department Elective- IV	3	0	0	3
	Total	**15**	**1**	**3**	**17.5**

Department of Electrical and Computer Science Engineering

Course Curriculum of M. Tech Electrical Infrastructure

Semester – III

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
EE6501	Seminar	0	0	0	2
EE6502	Thesis - I	0	0	0	22
	Total				**24**

Semester – IV

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
EE6503	Thesis - II	0	0	0	24
	Total				**24**

List of Department Electives

Course Code	Course Name
EE195011	Digital Image Processing
EE195009	Adaptive and Non Linear Control
EE195004	Advanced Power System
EE195006	Transportation Electrification
EE5008	Satellite Communication
EE195003	Intelligent Systems and Control

M. Tech Electrical Infrastructure

Semester – I

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE195001</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Special Electrical Machines</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>3</td><td>4.5</td></tr>
<tr><td>IV</td><td>Prerequisite (if any for the student)</td><td colspan="4">Electrical Machines</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Permanent Magnet Brushless D.C. Motors - Fundamental equations; EMF and Torque equations; Torque speed characteristics; Rotor position sensing; Sensorless motors; Motion control. Permanent Magnet Synchronous Motors – Construction; Principle of operation; EMF and torque equations; Starting; Rotor configurations; Dynamic model. Synchronous Reluctance Motors - Constructional features; axial and radial flux motors; operating principle; characteristics Switched Reluctance Motors - Constructional features; principle of operation; torque production; characteristics; power controllers Stepping Motors – Features; fundamental equations; PM stepping motors; Reluctance stepping motors; Hybrid stepping motors; Torque and voltage equations; characteristics</td></tr>
<tr><td>VI</td><td>Text Books</td><td colspan="4">1. K. Venkataratnam, “Special Electrical Machines”, Universities Press
2. T. J. E. Miller, “Brushless Permanent Magnet and Reluctance Motor Drives”, Oxford Science Publications</td></tr>
</table>

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Semester – I

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE195002</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Power Electronic Converters Operation Design and Control</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>3</td><td>4.5</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">Network Theory, Analog Electronics, Digital Electronics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Peripheral Design Aspects: power semiconductor devices characteristics; device selection for target application, design considerations for gate drive, magnetic components, filters, snubbers, heat sinks.

AC-DC Converters: line & forced commutated 1-ph & 3-ph converters; multi-pulse converters, input p.f.-current requirements, regeneration.

DC-AC Converters: 2-level, multilevel, modular converter topologies; switching-control schemes.

DC-DC Converters: non-isolated/isolated unidirectional/bidirectional converter topologies, control schemes.

Applications of Converters: overview of converters applications.</td></tr>
<tr><td>VI</td><td>Textbook Reference Books</td><td colspan="4">1. Power Electronics: Converters Applications and Design Mohan, Undeland and Robbins, 3rd edition – Wiley
2. Power Electronics Handbook M. H. Rashid, Academic Press</td></tr>
</table>

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Semester – I

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE5001</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Renewable Energy Infrastructure</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">Basics of Electrical and Electronics Engineering, Power Systems</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Sustainability: Why Energy Matters (and Money); Global Warming (Physics), History and Impact; Renewable Sources that are replenished: Wind, Solar, Ocean Waves, Geothermal; Wind Energy: Forecasting Challenges, Wind Turbines: Dynamics and Control, Wind Wakes; Solar Energy: Harnessing the Power of Sun: Science and Technology of Solar Photovoltaics (PV), Solar PV Connection to virtual Grid, Optimization issues; Renewable Energy storage Issues, Challenges; Hybrid Solar-Wind System; Wind Farm; Solar Farm; Policy and Ethical Issues; Energy Conservation related issues; Hydrogen and Fuel Cells; Bio-energy.</td></tr>
<tr><td>VI</td><td>Textbook/ Reference Books</td><td colspan="4">1. Wind Energy Handbook, 2nd Edition, Tony Burton, Nick Jenkins, DavidSharpe, Ervin Bossanyi

2. Solar Electricity Handbook - 2015 Edition: A simple, practical guide to solar energy - designing and installing solar PV systems, Michael Boxwell, Greenstream Publishing; 2015 Edition

3. Hydrogen and Fuel Cells: A volume in Sustainable World, Bent Sorensen

4. Non-conventional Energy Resources, B H Khan, Third Edition, McGrawHill Education</td></tr>
</table>

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Semester – II

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE195007</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Power Transmission and Distribution Systems</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite (if any for the student)</td><td colspan="4">Power Systems, Power Electronics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Transmission system:
Introduction to power transmission systems: AC and DC transmission systems.
DC Transmission system:
HVDC system configurations. Components of HVDC transmission. Converter theory and performance equations. Control of HVDC systems.
AC Transmission system:
Overview of Electrical power transmission at high voltages. HV cable transmission: Underground cables and Gas insulated transmission lines. HV substations - AIS and GIS. Role of FACTS (Flexible AC Transmission Systems) devices in HV transmission.

Distribution system:
Structure of a distribution system: Distribution feeder configurations and substation layouts. Overview of distribution system planning and design considerations. Voltage-drop and power loss calculations. Application of capacitors in the distribution system. Impact of participation of renewables and energy storage.</td></tr>
<tr><td>VI</td><td>Text/Reference Books</td><td colspan="4">1. K.R. Padiyar, HVDC Power Transmission Systems, Wiley eastern Ltd. 1990.
2. R. D. Begamudre, Extra High Voltage AC Transmission Engineering, New Age International, 2006.
3. Turan Gonen, Electrical Power Distribution Engineering, CRC Press, New York, 2014.</td></tr>
</table>

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Semester – II

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">HS225003</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Research Methodology</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite (if any for the student)</td><td colspan="4">No</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction to engineering research: Definition, characteristics and types, basic research terminology, qualities of a researcher, research methods vs methodology, overview of engineering research methods, role of Information and Communication Technology (ICT) in research, research ethics, intellectual property rights and scholarly publishing.

Research formulation: Defining and formulating the research problem, selecting the problem, necessity of defining the problem, literature survey – significance in defining a problem, various sources, critical review, identifying gap areas from literature review and research databases, development of working hypothesis.

Research design and data analysis: Research design – basic principles, need of research design, features of good design, important concepts relating to research design, observation and facts, laws and theories, method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis, hypothesis testing, generalization and interpretation.

Technical writing: Types (thesis, report, journal papers etc.), qualities, structure and components of good technical document, use of software tools (Word processing, latex, etc.), illustrations and tables, bibliography, referencing and footnotes. Oral presentation – planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication.</td></tr>
<tr><td>VI</td><td>Text/reference Books</td><td colspan="4">1. Blessing, L.T.M., Chakrabarti, A., DRM, a Design Research Methodology, Springer, 2009, ISBN: 978-1-84882-586-4.
2. Chandra, S., Sharma, M.K., Research Methodology, Narosa Publishing House, 2013, ISBN: 978-81-8487-246-0.</td></tr>
</table>

		3. Cohen, L., Manion, L., Morrison, K., Research Methods in Education, Routledge (Taylor and Francis Group), 2011, ISBN: 978-0-415-58336-7. 4. Goddard, W., Melville, S., Research Methodology – an Introduction, Juta and Company Ltd., 2004, ISBN: 978-0-702-15660-1. 5. Kothari, C.R., Garg, G., Research Methodology – Methods and Techniques, New Age International, 2014, ISBN: 978-81-224-3623-5. 6. Kumar, R., Research Methodology – a Step-by-Step Guide for Beginners, SAGE, 2011, ISBN: 978-1-84920-300-5. 7. Pandey, P., Pandey, M.M., Research Methodology – Tools and Techniques, Bridge Centre, 2015, ISBN: 978-606-93502-7-0. 8. Panneerselvam, R., Research Methodology, PHI Learning Pvt. Ltd., 2014, ISBN: 978-81-203-4946-9. 9. Rugg, G., Petre, M., A Gentle Guide to Research Methods, Open University Press, 2007, ISBN: 978-0-335-21927-8. 10. Singh, Y.K., Fundamentals of Research Methodology and Statistics, New Age International, 2006, ISBN: 978-81-224-2418-8. 11. Walliman, N., Research Methods – the Basics, Routledge (Taylor and Francis Group), 2011, ISBN: 978-0-415-48994-2.

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Semester – II

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE195010</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Microgrid</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>3</td><td>4.5</td></tr>
<tr><td>IV</td><td>Exposure</td><td colspan="4">Power systems, power electronics and MATLAB/Simulink or any other simulation tool</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Evolution of microgrid concept and motivation; properties and definition of microgrid; microgrid components and their characteristics; AC/DC/Hybrid configurations; schematic representation; necessity and role of power electronic converters; parallel operation of inverters; distributed generation (DG) and their control; integration of DG and energy storage in microgrid; grid-forming/supporting/feeding operations; grid-interactive and islanded operations of microgrid; voltage and frequency regulation; active and reactive power flow control; centralized & decentralized control techniques; primary, secondary and tertiary control structures; energy management – generation-load-storage scheduling, loss minimization; ‘smart grid’ environment – EVs,V2G, DSM, net metering; protection – fault detection and analysis, plug-in and plug-out operation of DGs, islanding detection, transition between grid-tied and islanded operations, black-start operation; role and impact of communication in microgrid operation and control; case studies and emerging models.</td></tr>
<tr><td>VI</td><td>Textbook/ Reference Books</td><td colspan="4">1. Articles from reputed research journals and magazines.

2. K. R. Padiyar and A. M. Kulkarni, ‘Dynamics and control of electric transmission and microgrids, John Wiley & Sons.

3. R. Teodorescu, M. Liserre and P. Rodriguez, ‘Grid converters for photovoltaic and wind power systems’, John Wiley & Sons.

4. H. Farhangi and G. Joos, ‘Microgrid planning and design – a concise guide’, John Wiley & Sons.

5. S. Chowdhury, S.P. Chowdhury and P. Crossley, ‘Microgrids and active distribution networks, The Institution of Engineering and Technology.</td></tr>
</table>

		6. N. Hatziargyriou, 'Microgrids – architectures and control', John Wiley & Sons. 7. S. Sharkh, M. Abusara, G. Orfanoudakis and B. Hussain, 'Power electronic converters for microgrids', John Wiley & Sons. 8. R. Strzelecki and G. Benysek, 'Power electronics in smart electrical energy networks', Springer. 9. H. Bevrani, M. Watanabe and Y. Mitani, 'Power system monitoring and control', John Wiley & Sons.

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Department Elective

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE 195011</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Digital Image Processing</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction
Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Perspective Projection, Spatial Domain Filtering, sampling and quantization.

Spatial Domain Filtering
Intensity transformations, contrast stretching, histogram equalization, Cor-
relation and convolution, smoothing filters, sharpening filters gradient and
Laplacian.

Filtering in the Frequency domain
Fourier Transforms and properties, FFT (Decimation in Frequency and
Decimation in Time Techniques), Convolution, Correlation, 2-D sampling,
Discrete Cosine Transform, Frequency domain filtering.

Image Restoration
Basic Framework, Interactive Restoration, Image deformation and geometric transformations, image morphing, Restoration techniques, Noise characterization, Noise restoration filters, Adaptive filters, Linear, Position invariant degradations, Estimation of Degradation functions, Restoration from projections.

Image Compression
Encoder-Decoder model, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon's 1st Theorem, Huffman Coding, Arithmetic Coding, LZW coding, Transform Coding, Sub-image size selection, blocking artifacts, DCT implementation using FFT, Run length</td></tr>
</table>

		coding, JPEG, Lossless predictive coding, Lossy predictive coding, Wavelet based Image Compression **Morphological Image Processing:** Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, convex hull, thinning, thickening, skeletons, pruning, Geodesic Dilation, Erosion, Recon- struction by dilation and erosion. 5 **Image Segmentation** Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresh- olding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region based segmentation, Watershed algorithm
VI	Textbook/ Reference Books	1. Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods. Publisher: Pearson Education 2. A. K. Jain, Fundamentals of digital image processing, Prentice Hall, 1989. 3. W. K. Pratt, Digital image processing, Prentice Hall, 1989.

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Department Elective

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE195009</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Adaptive and Nonlinear Control</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">An Undergraduate Control Systems Course is mandatory for this Course.</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Adaptive Control: Introduction, Recursive parameter estimation, Model reference adaptive control, Adaptive pole placement control, Robust adaptive control schemes, Averaging-based analysis, Adaptive control of nonlinear systems; Nonlinear Control: Introduction, Second-order systems and Phase Plane Analysis, Fundamentals of Lyapunov Stability Theory, Advanced Stability Theory, Stabilization and Global Feedback Linearization: differential geometric method, Nonlinear Control Design Tools: Lyapunov redesign, Backstepping, Nonlinear Observers, Nonlinear Output Regulation, Passivity and Dissipativity</td></tr>
<tr><td>VI</td><td>Textbook/ Reference Books</td><td colspan="4">1. Petros Ioannou and Baris Fidan, Adaptive Control Tutorial, SIAM, 2006.

2. K. J. Astrom and B. Wittenmark, Adaptive Control, 2nd Edition, Addison-Wesley, 1995

3. P. A. Ioannou and J. Sun, Robust Adaptive Control, Prentice-Hall, 1995.

4. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems, Prentice-Hall, 1989

5. S. Sastry and M. Bodson, Adaptive Control, Prentice-Hall, 1989

6. M. Krstic, I. Kanellakopoulos, and P. Kokotovic, Nonlinear and Adaptive Control Design, Wiley-Interscience, 1995

7. H. K. Khalil, Nonlinear Systems, Prentice Hall, 3rd edition, 2002</td></tr>
</table>

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Department Elective

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE195004</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Advanced Power System</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">Power Systems</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Operating states of power system. State-transition diagram. Introduction to power system security analysis. Major components of on-line security analysis.

Introduction to power system state estimation. Processes involved in state estimation: observability analysis, bad data detection and identification. Power system state estimation using method of least squares: Statistics, errors, and estimates, test for bad data. Structure and formation of H-matrix.

Introduction to synchro-phasor technology, Phasor Measurement Unit (PMU): Structure, operation and applications. Phase angle estimation techniques in distribution systems: Phase Locked Loop (PLL), and Discrete Fourier Transform (DFT) based approaches.

Phase shifting transformer in transmission lines: Modeling and admittance matrix formulation.

Revision of gauss-seidal and newton-raphson power flow analysis, concept of distributed slack and distributed slack power flow analysis. Optimal power ow analysis: formulation of objective function and constraints.

Representation of loads in power system: constant impedance, constant current and constant power loads. ZIP model and composite load representation.</td></tr>
<tr><td>VI</td><td>Text/reference Books</td><td colspan="4">J. J. Grainger, W. D. Stevenson Jr, Power System Analysis, Mc-Graw Hill Publications.

Literature work reported in IEEE Xplore digital library.</td></tr>
</table>

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Department Elective

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE5008</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Satellite Communication</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite (if any for the student)</td><td colspan="4">No</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Kepler’s Laws, Newton’s law, orbital parameters, orbital perturbations, station keeping, geo stationary and non-Geo-stationary orbits – Look Angle Determination- Limits of visibility -eclipse-Sub satellite point – Sun transit outage-Launching Procedures - launch vehicles and propulsion.
Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and supporting subsystems, Telemetry, Tracking and command. Satellite uplink and downlink Analysis and Design, link budget, E/N calculation- performance impairments-system noise, inter modulation and interference, Propagation Characteristics and Frequency consideration System reliability and design lifetime, Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, Assignment Methods, Spread Spectrum communication, compression – encryption, Transponder and their Access, Transmitter and Receiver, Antenna Systems TVRO, MATV, CATV, Test Equipment Measurements on G/T, C/No, EIRP, Antenna Gain, INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Direct Broadcast satellites (DBS)- Direct to home Broadcast (DTH), HTS, Digital audio broadcast (DAB), Satellite Navigational System, GPS, IRNSS.</td></tr>
<tr><td>VI</td><td>Text Books</td><td colspan="4">1. Timothy Pratt, Charles Bostian, Jeremy Allnutt, “Satellite Communication”, John Wiley International 2006.

2. Dennis Roddy, “Satellite Communications”, McGraw Hill 2014.</td></tr>
<tr><td>VII</td><td>Reference Books</td><td colspan="4">1. Louis J. Ippolito “Introduction to Satellite Communications “John Wiley International 2018.

2. TERESA M. BRAUN, “Satellite Communications Payload and System” John Wiley International 2018.</td></tr>
</table>

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Department Elective

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE 195003</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Intelligent Systems and Control</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite (If any for the student)</td><td colspan="4">Control Systems</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction of Artificial Intelligence: Background and related fields.

Biological foundations to Fuzzy logic, knowledge representation and inference mechanism, (Takagi - Sugeno and Mamdani Inference systems, design example), Fuzzy and expert control PD, PI and PID type Fuzzy Logic Controller.

Biological foundations to Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks. Controller design using NN, Examples
Application of neuro-fuzzy inference systems to robotics
System identification using neural and fuzzy neural networks.

Genetic Algorithm and applications, Parametric optimization of fuzzy logic controller. and NN controllers.

Intelligent controller applications to ball and beam system, helicopter system, flight system, robot manipulator, inverted pendulum and inertia wheel pendulum control and visual motor coordination.</td></tr>
<tr><td>VI</td><td>Reference books:</td><td colspan="4">1. Intelligent Control Systems Using Soft Computing Methodologies, Edited by Ali Zilouchian Mo Jamshidi, CRC press, 2001.

2. Intelligent systems and control,:Principles and applications, L. Behera and I Kar, Oxford, 2009

3. Intelligent Control A Hybrid - Approach Based on Fuzzy Logic, Neural Networks and Genetic Algorithms by Nazmul Siddique, Springer 2013</td></tr>
</table>

Department Elective

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE 195006</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Transportation Electrification</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction and History of Electric Vehicle, Electric Machines: DC Motors, Induction Motors and Permanent Magnet Motors in Electric Vehicle, Batteries: Introduction to Batteries, Battery Design and Management, Electric Drive Trains, Vehicle Dynamics, Steering and Braking, Wireless Power Transfer, Electric Systems for Marine and Aircraft Application.</td></tr>
<tr><td>VI</td><td>Reference books:</td><td colspan="4">1. Advanced Electric Drive Vehicles by Ali Emadi, CRC Press
2. Electric Vehicle Battery Systems by Sandeep Dhameja, Newnes</td></tr>
</table>