Electrical Engineering

Semester VII

Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
EE4001	Renewable Energy	3	0	2	4
EE400x	Department Elective - II	3	0	3	5
EE400x	Open Elective - I	3	0	0	4
EE4501	B.Tech Project - I	0	0	3	4
HS4001	HSS - V Infrastructure Planning and Management	3	0	0	4
	Total	**12**	**0**	**8**	**21**

Department Elective- II

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
EE4002	Digital Signal Processing	3	0	3	5
EE4003	Flexible AC Transmission Systems (FACTS)	3	0	3	5

Open Elective- I

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
EE4004	Digital Control	3	0	0	4
EE4005	Renewable Energy Systems	3	0	0	4

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I	Course Code	**EE4001**			
II	Course Title	**Renewable Energy**			
III	Credit Structure	L	T	p	C
		3	0	2	4
IV	Prerequisite(If any for the student)	Power System			
V	Course Content	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: The plants work and let us reap.			
VI	Text/References	1. Wind Energy Handbook, 2nd Edition, Tony Burton, Nick Jenkins, David Sharpe, Ervin Bossanyi, ISBN: 978-0-470-69975-1 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, ISBN-13: 978-1907670459 3. Hydrogen and Fuel Cells: A volume in Sustainable World, Bent Sorensen, ISBN: 978-0-12-387709-3			

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<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE4002</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">DE-II Digital Signal 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>3</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Signals and Systems</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction to discrete-time signals and systems; linear time invariant (LTI) systems and properties, linear phase systems; brief review of Fourier representations; sampling and reconstruction of continuous-time signals; the z-transform, properties and applications to LTI systems; the discrete Fourier transform (DFT), properties, efficient DFT computation by FFT, effects of finite word length; linear and circular convolutions, block convolutions for long sequences; Signal analysis by DFT, spectral analysis by periodogram and autocorrelation estimates; brief review of analog filter design; IIR filters, stability, design by impulse invariance, bilinear transformations, frequency transformations of low pass IIR filters; FIR filter design by windowing method and Parks-McClellan algorithm, finite precision numerical effects; decimation and interpolation of signals, quadrature mirror filters and perfect reconstruction, subband decomposition; introduction to discrete wavelet transforms.</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">1. S. K. Mitra: Digital Signal Processing- A Computer based Approach, Mc Graw Hill. 2nd edition

2. A.V. Oppenheim and R. W. Schafer: Digital Signal Processing, Prentice Hall.

3. John. G. Proakis and Monolakis: Digital Signal Processing, Pearson Education

4. Ingle VK and Proakis John G : Digital Signal Processing A MATLab based Approach, Cengage Learning

5. Salivahanan and Vallavraj: Digital Signal Processing, Mc Graw Hill.

6. L.R. Rabiner and B. Gold: Theory and Application of Digital Signal Processing, Prentice Hall

7. Johnny R. Johnson: Introduction to Digital Signal Processing, PHI, New Delhi.

8. Schilling and Harris: Fundamentals of DSP using MATLAB, Cengage Learning.</td></tr>
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I	Course Code	**EE4003**			
II	Course Title	**DE-II Flexible AC Transmission Systems (FACTS)**			
III	Credit Structure	L	T	p	C
		3	0	3	5
IV	Prerequisite(If any for the student)	Power System			
V	Course Content	Principle of compensators - VAr control, Passive reactive power compensation and design aspects- shunt passive compensator and series passive compensator; FACTS controllers based on Thyristors, based on self-commutated switches; Type of FACTS controllers - Shunt connected controllers - Static VAr compensator (SVC) and its configurations and Static Synchronous compensator (STATCOM), performance comparison of SVC and STATCOM; Series connected controllers - TCSC, SSSC and TCPAR, Unified Power flow controller, Applications of FACTS controllers - stability improvement and congestion management in power system, case study discussion in Indian power grid.			
VI	Text/References	1. Hingorani N.G. and GyugyiL., Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, Standard Publishers Distributors, 1st Indian Edition, 2001. 2. Padiyar, K.R., FACTS Controllers in Power Transmission and Distribution, New Age International, 1st Edition, 2007.			

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<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">EE40004</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Open Elective-I Digital 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>4</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Control System</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction to digital control : Basic building blocks of Discrete time Control system, Sampling Theorem, Z transform and Inverse Z transform for applications for solving differential equations, Mapping between the S-plane and the Zplane, Impulse sampling and Data Hold.

Pulse Transfer Function and Digital PID Controllers: The pulse transfer function, pulse transfer function of Closed Loop systems, Pulse transfer function of Digital PID controller, Velocity & Position forms of Digital PID Controller, Realization of Digital Controllers, Deadbeat response and ringing of poles.

Design of Discrete Time Control System by conventional methods: Stability analysis in Z-plane, Jury stability criterion, Bilinear transformations, Design based on the root locus method, Digital Controller Design using Analytical Design Method.

State Space Analysis of Discrete Time Control System : State space representation of discrete time systems, Solution of discrete time state space equations, Pulse transfer function matrix, Eigen Values, Eigen Vectors and Matrix Diagonalization, Discretization of continuous time state space equations, Similarity transformations.

Pole Placement and Observer Design: Concept of Controllability and Observability, Useful transformations in state space analysis and design, Stability improvement by state feedback, Design via pole placement, State observers.

Optimal Control: Quadratic Optimal Control and Quadratic performance index, Optimal state regulator through the matrix Riccati equations, Steady State Quadratic Optimal Control.</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">1. B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.

2. K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.

3. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003

4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Addison Wesley, 1998, Pearson Education, Asia, 3/e, 2000.

5. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.</td></tr>
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I	Course Code	**EE4005**			
II	Course Title	**Renewable Energy Systems**			
III	Credit Structure	L	T	p	C
		3	0	0	4
IV	Prerequisite(If any for the student)	Power System			
V	Course Content	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: The plants work and let us reap.			
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I	Course Code	**EE4501**			
II	Course Title	**B.Tech Project - I**			
III	Credit Structure	L	T	p	C
		0	0	3	4
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Students are required to carry out project under the supervision of faculty members for the defined objectives. The project includes the thesis submission and viva-voice.			
VI	Text/References				