SCHEME OF INSTRUCTION AND SYLLABI

M.TECH DEGREE IN

POWER ELECTRONICS AND DRIVES

(Department of Electrical & Electronics Engineering)

EFFECTIVE FROM 2016-2017

National Institute of Technology Delhi

(NIT DELHI)

M. Tech (Power Electronics and Drives) Course Structure

M.Tech (PED) 1 Year I Semester					
S.No		**Course**	**Course Title**	**L-T-P**	**C**
1		EEL 501	Power Electronics Devices & Converters (Mandatory)	3-0-0	3
2		EEL 5XX	Core-I	3-0-0	3
3		EEL 5XX	Core-II	3-0-0	3
4		EEL 5XX	Elective-I	3-0-0	3
5		EEL 5XX	Elective – II	3-0-0	3
6		EEP 504	Power Electronics Lab	0-0-3	2
7		EEP 505	Simulation of Power Electronic Systems	0-0-3	2
Total				**15-0-6**	**19**
M.Tech (PED) 1 Year II Semester					
S.No		**Course**	**Course Title**	**L-T-P**	**C**
1		EEL 551	Switched Mode Power converters (Mandatory)	3-0-0	3
2		EEL 5XX	Core-III	3-0-0	3
3		EEL 5XX	Core-IV	3-0-0	3
4		EEL 5XX	Elective – III	3-0-0	3
5		EEL 5XX	Elective – IV	3-0-0	3
6		EEP 554	Electrical Drives Lab	0-0-3	2
7		EEP 555	Seminar/Colloquium	0-0-2	1
Total				**15-1-5**	**18**
M.Tech (PED) II Year I Semester					
S.No		**Course**	**Course Title**	**L-T-P**	**C**
1		EEP 601	Dissertation		8
2		EEP 602	Independent Study and Seminar	0-0-4	2
3		EEL 6XX	Elective – V	3-0-0	3
4		EEL 6XX	Elective – VI	3-0-0	3
Total				**6-0-4**	**16**
M.Tech (PED) II Year II Semester					
S.No		**Course**	**Course Title**	**L-T-P**	**C**
1		EEP 651	Dissertation		12
2		EEP 652	Independent Study and Seminar		4
Total					**16**
Total Credits					**69**

Departmental Core

S.No	Course	Course Title	L-T-P
1	EEL 502	Dynamics of Electrical Machines	3-0-0
2	EEL 503	Electrical Drives	3-0-0
3	EEL 552	Advanced Electrical Drives	3-0-0
4	EEL 553	Power Electronics for Renewable Energy Systems	3-0-0

Departmental Elective

S.No	Course	Course Title	L-T-P
1	EEL 511	Power Quality	3-0-0
2	EEL 512	Flexible AC Transmission Systems (FACTs)	3-0-0
3	EEL 513	Digital Control in Power Electronic Systems	3-0-0
4	EEL 514	Digital Signal Processor & its applications to Power Electronics	3-0-0
5	EEL 515	Soft Computing and Applications	3-0-0
6	EEL 516	Analog Integrated Circuit Design	3-0-0
7	EEL 561	Robust Control	3-0-0
8	EEL 562	Special Electrical Machines	3-0-0
9	EEL 563	Applied Linear Algebra	3-0-0
10	EEL 564	Advanced Control Systems	3-0-0
11	EEL 565	FPGA based digital design techniques	3-0-0
12	EEL 566	Optimal Control	3-0-0
13	EEL 611	Electric Vehicles	3-0-0
14	EEL 612	AI Techniques and Applications	3-0-0
15	EEL 613	Energy Storage Devices	3-0-0
16	EEL 614	Energy Auditing and Management	3-0-0
17	EEL 615	Telemetry Systems	3-0-0
18	EEL 616	Internet of Things	3-0-0

Course no: EEL 501	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Power Electronics Devices & Converters**			
Course Coordinator				
Course objectives:	• To introduce students with the basic theory of power semiconductor, their practical application in power electronics. • To familiarize the operation principle of AC-DC, DC-DC, DC-AC conversion circuits and their applications. • To enhance the knowledge and understanding of power electronic converters and their application in power electronic systems. • To provide students with the skills and techniques necessary to analyze and synthesize power electronic circuits utilizing modern power electronic devices.			
POs				

Semester	Autumn: I Semester		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Power Electronics Converters, Applications, and Design
	Author	Ned Mohan, Tore M. Undeland, William P. Robbins
	Publisher	Wiley India Pvt Ltd
	Edition	3rd
2.	Title	Semiconductor Device Modeling with Spice
	Author	G. Massobrio, P. Antognetti
	Publisher	McGraw-Hill
	Edition	2nd
Reference Book:		
1.	Title	Power Semiconductor Devices

	Author	B. Jayant Baliga
	Publisher	International Thompson Computer Press
	Edition	1st
2.	Title	Discrete and Integrated Power semiconductor Devices: Theory and Applications
	Author	V. Benda, J. Gowar, and D. A. Grant
	Publisher	John Wiley & Sons
	Edition	1999

Content	**Unit I: Power Electronic Devices:** Overview of power switching devices such as: Thyristor, GTOs, BJTs, MOSFETs, and IGBTs etc. and their static and dynamic characteristics. Firing / Triggering techniques and commutation techniques. **Unit II: Phase Controlled Multi-pulse Converters:** Review of uncontrolled converters, Phase controlled converters: Single-Phase and Three-Phase full converters, semi-converters, Half-controlled converters, dual converters etc. Effect of source inductance, Harmonic Analysis, Extinction and Symmetrical Angle control, PWM control, SPWM control. Power Factor Correction rectifiers. **Unit III: AC Controllers and Cycloconverters :** Principle of phase control, Integral cycle control, Single phase voltage controllers, Sequence control of AC voltage controllers, step-up cycloconverter, step-down cycloconverter, three phase to single phase cycloconverter, three phase to three phase cycloconverter, carrier based control schemes & non-carrier based control scheme. **Unit IV: Switching Mode Inverters:** Basic concept of 1-Φ, 3-Φ Switching Inverters: 120o and 180o modes of operation, Inverter configurations Voltage-Source Inverter, Current-Source Inverter, Line Commutated Inverters, Unipolar and Bipolar Switching, PWM modulation techniques for Switching Inverters: single, multiple and sinusoidal, space vector modulation (SVM), Harmonic Reduction Techniques. Multi-Level Inverters: topologies and control strategies.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 502	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Dynamics of Electrical Machines**			
Course Coordinator				
Course objectives:	• To improve the analysis and solving problem skills related to electrical machines • To apply the theory of machine dynamics to induction motor starting, speed control, braking, and protection. • To develop the research, and design of power electronic circuits, automated systems, and electrical power systems.			
POs				

Semester	Autumn		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Analysis of Electrical Machines and Drive Systems
	Author	Krauss, Wasyncsuk and Sudholf
	Publisher	John Wiley
	Edition	3rd
2.	Title	Generalized Theory of Electrical Machines
	Author	PS. Bhimbra
	Publisher	Khanna Publishers
	Edition	2006
Reference Book:		
1.	Title	Electric Machinery
	Author	A E Fitzgerald, Kingsley, and Umans
	Publisher	McGraw Hill

	Edition	6th
2.	Title	Modern Power Electronics & AC Drives
	Author	Bimal K Bose
	Publisher	Pearson Education
	Edition	2002
Content	**Unit I: Introduction:** Unified approach to the analysis of electrical machine, basic two-pole machine, Kron's primitive machine, voltage, power and torque equation, linear transformation from 3-phase to 2-phase, transformation from rotating axes to stationary axes, power invariance, park's transformation for 3-phase synchronous and induction machines. **Unit II: DC Machines:** Application of generalized theory to separately excited, shunt, series and compound machines, sudden short circuit of separately excited generator, separately excited dc motor, steady state and transient analysis, transfer functions of separately excited dc generator & motor. **Unit III: Polyphase Synchronous Machines:** Generalized machine equations, steady state analysis of salient pole and non salient pole machines, phasor diagrams, power angle characteristics, reactive power, short circuit ratio, transient analysis, sudden 3-phase short circuit at generator terminals, reactance, time constants, transient power angle characteristics. **Unit IV: Induction Machines:** 3-phase induction machine, generalized model, voltage equation, steady state analysis, equivalent circuit, torque-slip characteristics, effect of voltage and frequency variations, electric transients in induction machines, speed control of induction motor, introduction to vector control, applications in speed control of induction machine.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EEL 503	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Electrical Drives**			
Course Coordinator				
Course objectives:	• To understand the basic principles of power electronics in drives to synthesize the voltages in dc and ac motor drives. • To understand the basic concepts of magnetic circuits as applied to electric machines. • To learn to use space vectors presented on a physical basis to describe the operation of an ac machine. • To earn about the energy efficiency of electric drives and inverter-motor interactions.			
POs				

Semester	Autumn		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Fundamentals of Electric Drives
	Author	Dubey G. K.
	Publisher	Narosa Publishing House
	Edition	2nd
2.	Title	A First Course in Electric Drives
	Author	Pillai S. K.
	Publisher	New Age International Private Limited
	Edition	2nd
Reference Book:		
1.	Title	Power Semiconductor Controlled Drives
	Author	Dubey G. K.
	Publisher	Prentice-Hall International Editions

	Edition	2001
2.	Title	Electric Motor Drives – Modelling, Analysis and Control
	Author	Krishnan R.
	Publisher	Prentice Hall of India Private Limited
	Edition	2007
3.	Title	Power Electronics and Variable Frequency Drives
	Author	Bose B. K.
	Publisher	IEEE Press, Standard Publisher Distributors,
	Edition	2001

Content	**Unit I: Introduction:** Definition of electric drive, types of load; Speed torque characteristic of driven unit/loads, motors, steady state and transient stability of drives; Classification and components of load torque; Selection of motor power capacity for different duty cycles. **Unit II: Speed Control of Motors:** Review of braking and speed control of dc motor and induction motor, multi-quadrant operation, loss minimization in adjustable speed drives. **Unit III: Converter fed DC Drives:** Principle of operation of converter fed separately excited dc motor drives, operation of dc drive under continuous and discontinuous armature current, armature voltage and current waveforms, effect of freewheeling diode, analysis and performance evaluation, expression for speed-torque characteristic; Dual converter fed dc drives, MATLAB simulation. **Unit IV: Chopper fed DC Drives:** Principle of operation, control techniques, steady state analysis of time ratio control and current limit control, closed loop control of dc drives; current control techniques, mathematical model of chopper fed dc drive, stability analysis. **Unit V: Inverter fed AC Drives:** Constant V/f controlled induction motors, controlled current and controlled slip operations; variable frequency controlled induction motor drives; PWM inverter drives, operation of closed loop slip-speed controlled VSI and CSI fed ac drives, multiquadrant operation, MATLAB simulation. **Unit VI: Synchronous Motor Drives:** Adjustable frequency operations, voltage fed and current fed self controlled drives.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEP504	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Power Electronics Lab**			
Course Coordinator				
Course objectives:	A student who successfully fulfills the course requirements will have: • The knowledge of analysis, design, simulation, and experimentation of various power electronics circuits including AC-DC, and DC-AC • The skills and knowledge of techniques necessary to analyze and synthesize power electronic circuits utilizing modern power electronic devices.			
POs				

Semester	Autumn: I Semester		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	0	0	3	2
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:

1.	Title	Power Electronics Laboratory: Theory, Practice & Organization
	Author	O. P. Arora
	Publisher	Alpha Science International Limited
	Edition	2007
2.	Title	Power Electronics Converters, Applications, and Design
	Author	Ned Mohan, Tore M. Undeland, William P. Robbins
	Publisher	Wiley India Pvt Ltd
	Edition	3rd
3.	Title	Semiconductor Device Modeling with Spice
	Author	G. Massobrio, P. Antognetti

	Publisher	McGraw-Hill
	Edition	2nd
Reference Book:		
1.	Title	Power Semiconductor Devices
	Author	B. Jayant Baliga
	Publisher	International Thompson Computer Press
	Edition	1st
2.	Title	Discrete and Integrated Power semiconductor Devices: Theory and Applications
	Author	V. Benda, J. Gowar, and D. A. Grant
	Publisher	John Wiley & Sons
	Edition	1999

Content	1. To study & operate MOSFET/IGBT with gate-base triggering circuit. 2. To study & operate single phase Semi converter with: a) R Load. b) RL load. c) RLE (Motor) Load 3. To study & operate single phase Fully controlled converter with: a) R Load. b) RL load. c) RLE (Motor) Load 4. To study & operate three phase semi converter 5. To study & operate three phase fully controlled converter 6. To study & operate single phase Dual converter 7. Simulation of single phase AC Voltage Controller. a) Lamp load b) Motor load 8. Simulation of three phase AC Voltage Controller. a) Lamp load b) Motor load 9. To study the operation of three phase full bridge inverter for: a) 180 degree mode b) 120 degree mode. 10. Simulation of PWM inverters with: a) Sinusoidal PWM b) Square PWM 11. To study & operate step-up cycloconverter for continuous and discontinuous mode. 12. To study & operate step-down cycloconverter for continuous and discontinuous mode.
Course Assessment	Continuous Evaluation 50% End Semester 50%

Course no: EEL 551	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Switched Mode Power converters**			
Course Coordinator				
Course objectives:	• To understand the concepts and basic operation of efficient switched-mode power conversion, including basic circuit operation and magnetics design. • To understand how to analyze and model steady-state converter operation, switch realization, and continuous/discontinuous operation modes for converters with and without transformer isolation. • To understand how to analyze and model design techniques related to magnetic components in switched-mode power converters. • To make practically acquainted with digital technology applications in control of switched mode power electronic converters			
POs	After successful completion of this course students will be able to: • Understand various approaches for the analysis and to model steady-state converter operation. • Understand dynamic of modeling of DC-DC converters, Resonant Converters etc. • Design and Model SMPS.			

Semester	Autumn		Spring: II Semester	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Fundamentals of Power Electronics
	Author	Robert W. Erickson, and Dragan Maksimovic
	Publisher	Springer

	Edition	2nd (2002)
2.	Title	Power Electronics: A first course
	Author	Ned Mohan
	Publisher	John Wiley & Sons, Inc.
	Edition	2012
Reference Book:		
1.	Title	Power Electronic Circuits
	Author	Issa Batarseh
	Publisher	John Wiley & Sons, Inc.
	Edition	2003
2.	Title	Power Electronics Handbook
	Author	M.H. Rashid
	Publisher	Butterworth-Heinemann
	Edition	3rd (2010)
3.	Title	Switching Power Supply design
	Author	Abraham I Pressman, Keith Billings, and Taylor Morey
	Publisher	McGraw-Hill Professional
	Edition	3rd

Content

Unit I: Application of Power Converters:

Power Supplies: Introduction to Linear Power Supplies, Overview of Switch-Mode DC Power Supply (SMPS). Power Conditioners and UPS. Electric Utility Applications of power electronic converters.

Unit II: DC-DC Converters:

Study of class A,B,C,D choppers, Non-Isolated Converters:- BUCK, BOOST, BUCK-BOOST, Cuk, SEPIC etc. steady-state and time-domain analysis in CCM & DCM mode of operation. Isolated Converter: – Classification, need of isolation, Basic concepts and analysis of Buck and Boost derived isolated converters such as Forward, Fly-Back, Push-Pull, Half-Bridge, Full-Bridge etc.

Unit III: Resonant Converters:

Classification of Resonant converters, Concepts of soft-switching, Zero-Voltage (ZVS) and Zero-Current Switching (ZCS), Classification of soft switching resonant converters. Introduction to Zero-voltage transition (ZVT) and zero current transition (ZCT) converters.

Unit IV: Design and Modeling of DC-DC Converters:

Design of power stage of converters: magnetic components, filter capacitor, selection of rating of devices, Thermal Design, Filter Design. Basic AC modeling, State-Space Average model, Circuit Averaging, Averaged Switched Model, Canonical Circuit Model. Derivation of converter transfer functions.

Unit V: Control of DC-DC Converters:

Mechanism of loop stabilization, Compensator design, Feedback control

	schemes for dc-dc converters such as voltage-mode control and current mode control etc. PWM techniques for converters.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 552	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Advanced Electrical Drives**			
Course Coordinator				
Course objectives:	• To understand that how to operate and maintain different types of DC/AC and special electrical machine drives in the industry • To understand the principle of soft switching in inverters and converters utilizing resonant circuits, modulation strategies and application in IM drives • To understand the application of modern and evolutionary techniques such as fuzzy and ANN control in Advanced electrical drives			
POs				

Semester	Autumn		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Power Semiconductor Controlled Drives
	Author	Dubey G. K.
	Publisher	Prentice-Hall International Editions
	Edition	2001
2.	Title	Power Electronics Control of AC Motors
	Author	Murphy J. M. D. and Turnbull F. G.
	Publisher	Peragmon Press.
	Edition	1990
Reference Book:		
1.	Title	Power Electronics and Variable Frequency Drives
	Author	Bose B. K.,
	Publisher	IEEE Press, Standard Publisher Distributors.
	Edition	2001
2.	Title	Electric Motor Drives – Modeling, Analysis and

		Control
	Author	Krishnan R.
	Publisher	Prentice Hall of India Private Limited
	Edition	2007
3.	Title	Control of Electric Drives
	Author	Leonard W.
	Publisher	Springer Press
	Edition	2007

Content	**Unit I: Review:** Power electronic converters for ac drive control, voltage source and current source inverters. LCI-IM Drive: Drive configuration, commutation at different speeds, mathematical modeling, control structure, resonance problem and performance. **Unit II: FOC-IM Drive:** Drive configuration, mathematical modeling, direct and indirect FOC, influence of parameters, VSI and CSI fed schemes, adaptive drive control. Brushless DC Drive: Self control, CSI with load commutation, low speed commutation, inverter control strategies and performance. **Unit III: Permanent Magnet SM Drive:** Principle of operation, converter configuration, synchronization, trapezoidal and sinusoidal drive control structures and performance. **Unit IV: Switched Reluctance Motor Drive:** Principle of operation, converter circuits, sensors, speed control and performance. **Unit V: Resonant-Link Converter fed Drive:** Principle of soft switching in inverters and converters utilizing resonant circuits, modulation strategies and application in IM drives. **Unit VI: Advanced Control Techniques:** Application of modern and evolutionary techniques in drives such as fuzzy and ANN control.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 553	**Open course (Y/N)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	Y	N
Course Title	**Power Electronics For Renewable Energy Systems**			
Course Coordinator				
Course objectives:	• To understand Environmental aspects of electric energy conversion • To understand electric energy conversion systems for Solar and PV Systems • To understand electric energy systems for Wind Energy Conversion Systems (WECS)			
POs				

Semester	Autumn		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Power Electronics Handbook
	Author	M.H. Rashid
	Publisher	Butterworth-Heinemann
	Edition	3rd (2010)
2.	Title	Non-conventional Energy sources
	Author	B.H. Khan
	Publisher	Tata McGraw-hill Publishing Company
	Edition	2009
Reference Book:		
1.	Title	Wind energy system
	Author	Gray, L. Johnson
	Publisher	Prentice Hall Inc.
	Edition	1995

2.	Title	Non conventional energy sources
	Author	Rai. G.D.
	Publisher	Khanna publishes
	Edition	1993
3.	Title	Solar energy utilization
	Author	Rai. G.D.
	Publisher	Khanna publishes
	Edition	1993

Content	**Unit I: Introduction:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. **Unit II: Electrical Machines for Renewable Energy Conversion:** Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG. **Unit III : Power Converters :** Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters-selection Of inverter, battery sizing, array sizing. Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. **Unit IV: Analysis of Wind and PV Systems:** Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system **Unit V: Hybrid Renewable Energy Systems:** Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-Maximum Power Point Tracking (MPPT).
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course No. EEL 554	Open Course (Yes/No)	HM Course (Y/N)	DC (Y/N)	DE(Y/N)
Type of the Course	N	N	Y	N
Course Title	**Electrical Drives Lab**			
Course Co-ordinator				
Course Objectives	The objective of this course is simulation of various AC and DC drives and experimental validation of some of them.			
POs				
Semester	Autumn		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	0	0	4	2
Pre-requisite course code as per proposed course members	Nil	Nil	Nil	0
Prerequisite credits	Nil	Nil	Nil	Nil
Equivalent course codes as per proposed course and old course	Nil	Nil	Nil	Nil
Overlap course codes as per proposed course numbers	Nil	Nil	Nil	Nil
Text Book(s)				
1.	**Title**	Modern Power Electronics and AC Drives		
	Author	Bimal K. Bose		
	Publisher	Prentice Hall PTR		
	Edition	2nd Edition		
Reference Book(s)				
1.	**Title**	Electric Motor Drives – Modeling, Analysis & Control		
	Author	R. Krishnan		
	Publisher	Prentice Hall		
	Edition	2nd Edition		
Content	**Student ought to perform any three out of the following:** 1. To perform dynamic simulation of speed controlled DC motor drive 2. To simulate speed control of Kramer Drive 3. To simulate Field Oriented Control (FOC) of a three-phase induction motor without using speed sensors. 4. To simulate Direct Stator Flux and Torque control (DSFTC) of a three-phase induction motor.			

	5. To simulate open-loop volts/hertz control of synchronous motor drive. 6. To simulate and experimentally validate V/F control of a three-phase induction motor using micro-controller. 7. To simulate speed control of a BLDC motor drive employing Hall-sensors.
Course Assessment	Continuous Evaluation - 50% End Semester - 50%

Course No. EEL 511	Open Course (Yes/No)	HM Course (Y/N)	DC (Y/N)	DE(Y/N)
Type of the Course	N	N	N	Y
Course Title	**Power Quality**			
Course Co-ordinator				
Course Objectives	The objectives of the course include introduction of the power quality definitions, voltage sags, interruptions, harmonic problems and mitigation.			
POs				
Semester	Autumn		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	36	0	0	3
Pre-requisite course code as per proposed course members	Nil	Nil	Nil	0
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				
Text Book(s)				
1.	**Title**	Electrical Power Systems Quality		
	Author	Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H.Wayne Beaty		
	Publisher	McGraw Hill Education		
	Edition	Third Edition		
Reference Book(s)				
1.	**Title**	Power System Harmonic Analysis		
	Author	Arrillaga J., Smith B. C., Watson N. R. and Wood A. R		
	Publisher	Wiley India		
	Edition	2nd Edition		
2.	**Title**	Power System Analysis		
	Author	Arthur R.B.		
	Publisher	Pearson Education		
	Edition	2nd Edition		
3.	**Title**	Power Quality		

	Author	Sanskaran
	Publisher	C.R.C. Press
	Edition	2nd Edition
Content	**Unit I: Concept of Power Quality:** Frequency variations, voltage variations- sag and swell, waveform distortion –dc offset, harmonics, inter-harmonics, notching and noise. **Unit II: Fundamentals of Harmonics:** Representation of harmonics, waveform, harmonic power, measures of harmonic distortion; Current and voltage limits of harmonic distortions: IEEE, IEC, EN, NORSOK **Unit III: Causes of Harmonics:** 2-pulse, 6-pulse and 12-pulse converter configurations, input current waveforms and their harmonic spectrum; Input supply harmonics of AC regulator, integral cycle control, cycloconverter, transformer, rotating machines, ARC furnace, TV and battery charger. **Unit IV: Effect of Harmonics:** Parallel and series resonance, effect of harmonics on static power plant – transmission lines, transformers, capacitor banks, rotating machines, harmonic interference with ripple control systems, power system protection, consumer equipments and communication systems, power measurement. **Unit V: Elimination/ Suppression of Harmonics:** High power factor converter, multi-pulse converters using transformer connections (delta, polygon) **Unit VI: Filters:** Passive Filters: Types of passive filters, single tuned and high pass filters, filter design criteria, double tuned filters, damped filters and their design. Active Power Filters: Compensation principle, classification of active filters by objective, system configuration, power circuit and control strategy. Shunt Active Filter: Single-phase active filter, principle of operation, expression for compensating current, concept of constant capacitor voltage control; Three-phase active filter: Operation, analysis and modelling; Instantaneous reactive power theory. Three-phase Series Active Filter: Principle of operation, analysis and modelling.	
Course Assessment	Continuous Evaluation - 25% Mid Semester - 25% End Semester - 50%	

Course No. EEL 512	Open Course (Yes/No)	HM Course (Y/N)	DC (Y/N)	DE(Y/N)
Type of the Course	N	N	N	Y
Course Title	**Flexible AC Transmission Systems (FACTs)**			
Course Co-ordinator				
Course Objectives	The objective of this course is introduction of various FACTs devices, their applications and their co-ordination			
POs				
Semester	Autumn		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Pre-requisite course code as per proposed course members	Nil	Nil	Nil	0
Prerequisite credits	Nil	Nil	Nil	Nil
Equivalent course codes as per proposed course and old course	Nil	Nil	Nil	Nil
Overlap course codes as per proposed course numbers	Nil	Nil	Nil	Nil
Text Book(s)				
1.	**Title**	Thyristor – Based Facts Controllers for Electrical Transmission Systems		
	Author	Mohan Mathur, R., Rajiv. K. Varma		
	Publisher	IEEE press and John Wiley & Sons, Inc.		
	Edition	2nd Edition		
Reference Book(s)				
1.	**Title**	Reactive power control in Electrical system		
	Author	T. J. E. Miller		
	Publisher	John Wiley & Sons		
	Edition	3rd Edition		
2.	**Title**	FACTS CONTROLLERS in Power Transmission & Distribution		
	Author	K. R. Padiyar		
	Publisher	New Age International (P) Ltd., 2007		
	Edition	2nd Edition		

3.	**Title**	Understanding FACTS Concepts & Technology of FACTS Systems,
	Author	Hingorani N. G
	Publisher	IEEE PRESS, 2000
	Edition	1st Edition
Content	**Unit I: Introduction:** The concept of flexible AC transmission, reactive power control in electrical power transmission lines, uncompensated transmission line, series and shunt compensation, Overview of FACTS devices: Static Var Compensator (SVC), Thyristor Switched Series capacitor (TCSC), Unified Power Flow controller (UPFC), Integrated Power Flow Controller (IPFC). **Unit II: Static VAR Compensator (SVC) and Applications:** Voltage control by SVC, advantages of slope in dynamic characteristics, influence of SVC on system voltage, Applications: enhancement of transient stability, steady state power transfer, enhancement of power system damping, prevention of voltage instability. **Unit III: Thyristor Controlled Series Capacitor (TCSC) and Applications:** Operation of the TCSC, different modes of operation, modelling of TCSC, variable reactance model, modelling for stability studies, applications: improvement of the system stability limit, enhancement of system damping, voltage collapse prevention. **Unit IV: Emerging FACTS Controllers:** Static Synchronous Compensator (STATCOM): operating principle, V-I characteristics, Unified Power Flow Controller (UPFC): Principle of operation, modes of operation, applications, modeling of UPFC for power flow studies. **Unit V: Co-ordination of FACTS Controllers:** FACTs Controller interactions, SVC–SVC interaction, co-ordination of multiple controllers using linear control techniques, Quantitative treatment of control coordination.	
Course Assessment	Continuous Evaluation - 25% Mid Semester - 25% End Semester - 50%	

Course no: EEL 513	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				YES
Course Title	**Digital Control in Power Electronic Systems**			
Course Coordinator	To introduce different digital control methods available to control power electronic systems.			
Course objectives:				
POs				

Semester	Autumn:		Spring:	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:

1.	Title	Digital control in power electronics
	Author	Simone Buso, paolo Mattavelli
	Publisher	Morgan & Claypool Publishers
	Edition	1st
2.	Title	Digital control engineering analysis and design
	Author	1. M.Sam Fadali
	Publisher	Academic Press
	Edition	2nd
3.	Title	Modern Control Engineering
	Author	K. Ogata
	Publisher	Prentice Hall
	Edition	3rd
4.	Title	Modern Power Electronics and AC Drives
	Author	B. K. Bose
	Publisher	Pearson Publications
	Edition	1st

Content	**Unit I: Introduction** Digital Control Application to Power Electronic Circuits. Modern Power Electronics, Need for Digital Control, Trends and Perspectives **Unit II: The Test Case: a Single-Phase Voltage Source Inverter:** The voltage source inverter: Fundamental components, Required Additional Electronics: Driving and Sensing, Principle of operation, Dead Times Low Level Control of the Voltage Source Inverter: PWM Modulation, Analog PWM : The Naturally Sampled Implementation, Digital PWM: the Uniformly Sampled Implementation, Single Update and Double Update PWM Mode, Minimization of Modulator Delay: a Motivation for Multisampling. Analog Control Approaches: Linear Current Control: PI Solution, Non-linear Current Control: Hysteresis Control **Unit III: Digital Current Mode Control:** Requirements of the Digital Controller: Signal Conditioning and Sampling, Synchronizing between Sampling and PWM, Quantization Noise and Arithmetic Noise Basic Digital Current Control Implementations: The Proportional Integral Controller: Overview, Simplified Dynamic Model of Delays, The Proportional Integral Controller: Discretization Strategies, Effects of the Computation Delay, Derivation of a Discrete Time Domain Converter Dynamic Model, Minimization of the Computation Delay, The Predictive Controller **Unit IV: Extension to Three Phase Systems:** The αβ transformation, Space Vector Modulation: Space Vector Modulation based controllers, The Rotating Reference frame Current Controller: Park's transformation, Design of rotating reference frame PI Current Controller, A Different Implementation of the Rotating Reference Frame PI Current Controller
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 514	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				YES
Course Title	**Digital Signal Processor and its application to Power Electronics**			
Course Coordinator				
Course objectives:	To introduce different digital signal processors and their applications in electrical engineering.			
POs				

Semester	Autumn:		Spring:	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:

1.	Title	Multirate Systems and Filter Banks
	Author	P. P. Vaidyanathan
	Publisher	Prentice-Hall o
	Edition	1st
2.	Title	Optimum Signal Processing
	Author	S. J. Orfanidis
	Publisher	McGraw-Hill
	Edition	2nd
3.	Title	Introduction to DSP
	Author	Proakis, Manolakis
	Publisher	Prentice-Hall of India Private Limited, Pearson
	Edition	
4.	Title	Discrete Time Signal Processing
	Author	A.V. Oppenheim and R. W. Schafer

	Publisher	Prentice-Hall of India Private Limited
	Edition	3rd
Content	**Unit I: Introduction** Fixed and floating-point processors Number formats and operations: Fixed point 16 bit numbers representations of signed integers and fraction, Floating Point Numbers. Review of commonly used DSP processors in power electronics applications, Introductions to TMS320C2000. **Unit II: DSP Architecture, peripherals and programming** Introduction to Digital control using DSP, Overview of TMS320XXXXX Digital signal controller family – Features, Architecture, Interrupt and Reset, Memory map - On-chip memories: Flash, RAM, and Boot ROM – External memory Interface. Clock system- Digital I/O -CPU Timers – Analog to Digital Converter (ADC), Pulse Width Modulator (PWM), High Resolution PWM, Capture Module, Quadrature Encoder Pulse Module. Controller Area Network, Serial Communication Interface, Serial Peripheral Interface, I2C and Multi-channel Buffered Serial port. Programming: assembler, linker processes, code structure, Code composer studio. **Unit III: Mathematical Tools for Real time DSP implementation** Review of numerical integration: Euler's implicit and explicit method, Heun's Method, Trapezoidal Method. Implementation of low pass filter. Review of reference frame transformation theory. Design of controllers for closed loop applications in power electronics: PI, Type II and Type III controllers. **Unit IV: DSP Applications in Power Electronics and Power systems** Speed control of Induction motor, BLDC motor, Digital control of DC/DC converter, LED Lighting. Issues of harmonics and unbalanced currents in power systems, Implementation of Active filters in DSP under balanced and unbalanced condition, harmonic oscillator and 3 phase lock loop, Static VAR Compensator, Hardware in Loop simulations. Design of a DSP controlled Solar PV based Converter/Inverter system	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EEL 515	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	N	Y
Course Title	**Soft Computing and Applications**			
Course Coordinator				
Course objectives:	1. Introduce students to soft computing concepts and techniques and raise their abilities in designing and implementing soft computing based solutions for real-world and engineering problems. 2. The student should be able to get an idea on • Neural Networks, architecture, functions and various algorithms involved • Fuzzy Logic, Various fuzzy systems and their functions. • Genetic algorithms, its applications and advances			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0		
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Neuro-Fuzzy and Soft Computing
	Author	J.S.R. Jang, C.T. Sun and E. Mizutani
	Publisher	Prentice Hall
	Edition	
2.	Title	Neural Networks & Learning Machines,
	Author	Simon O. Haykin
	Publisher	Prentice Hall
	Edition	

<table>
<tr><td colspan="4">Reference Book:</td></tr>
<tr><td colspan="2" rowspan="4">1.</td><td>Title</td><td>An Introduction to Genetic Algorithms</td></tr>
<tr><td>Author</td><td>M. Mitchell</td></tr>
<tr><td>Publisher</td><td>MIT Press</td></tr>
<tr><td>Edition</td><td></td></tr>
<tr><td colspan="2" rowspan="4">2.</td><td>Title</td><td>Fundamentals of Computational Swarm Intelligence</td></tr>
<tr><td>Author</td><td>Andries P. Engelbrecht</td></tr>
<tr><td>Publisher</td><td>Wiley-Blackwell</td></tr>
<tr><td>Edition</td><td></td></tr>
<tr><td>Content</td><td colspan="3">Unit I: Introduction:
Basic mathematics of soft computing; Learning and statistical approaches to regression and classification.
Unit II: Support Vector Machines:
Risk minimization principles; VC Dimension; Structural risk minimization; SVM Algorithms.
Unit III: Neural Networks:
Single layer perceptron; ADALINE; LMS algorithm; Multi layer perceptron; Hopfiled networks; Associative memory networks; Radial Basis function networks; Principal component analysis; Self Organizing Maps.
Unit IV: Fuzzy Logic Systems:
Basics of fuzzy set theory; Approximate reasoning; Defuzzificaiton methods; Fuzzy rule based system. T-S fuzzy system; Mamdani fuzzy system
Unit V: Meta-Heuristic Optimization Techniques:
Population based meta-heuristic optimization: Genetic algorithms, Ant colony optimization, Particle swarm optimization.</td></tr>
<tr><td>Course Assessment</td><td colspan="3">Continuous Evaluation 25%
Mid Semester 25%
End Semester 50%</td></tr>
</table>

Course no: EEL 516	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	N	Y
Course Title	**Analog Integrated Circuit Design**			
Course Coordinator				
Course objectives:	The subject aims to provide the student with • An understanding of basic ideas on which analysis and design of analog circuits and systems are based, including operational amplifier. • The capability to use ideas to analyze and design simple electronic circuits. • The linear and non-linear applications of operational amplifiers.			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0		
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Applications and design with Analog Integrated Circuits
	Author	J. Michael Jacob
	Publisher	PHI
	Edition	2nd Edition, 2004
2.	Title	Analysis and Design of Analog Integrated Circuits
	Author	Gray, Hurst, Lewis, *Meyer*
	Publisher	Wiley
	Edition	fifth Edition

Reference Book:		
1.	Title	*Design of Analog CMOS Integrated Circuits*
	Author	BehzadRazavi
	Publisher	McGraw-Hill
	Edition	August 2000
2.	Title	Design with operational amplifiers and analog integrated circuits
	Author	Sergio Franco
	Publisher	McGraw-Hill
	Edition	August 2001

Content	**Unit I: IC Op-Amp Applications:** OP-AMP Fundamentals (brief review of differential amplifier, current mirror, active load, level shifter, output stage; ac and dc characteristics) Basic building blocks using OP-AMPS. Inverting/Non-inverting VCVS, Integrators, Differentiators, CCVS and VCCS, Instrumentation Amplifiers. **Unit II: Waveform Generators:** Square wave generators: 555Timer, Crystal controlled Oscillator Ramp Generator: Triangle generator, Sawtooth generator Sine wave generator: Requirement for sinusoidal oscillations, Wien-bridge and twin-T oscillators. Function Generators: Multi op-amp function generators, IC function generators Digitally controlled frequency synthesizer: PLL Fundamentals, PLL synthesizer, Totally digital synthesizer. **Unit III: Active Filters:** Introduction to filtering: Frequency response, Characteristics and terminology, Active versus passive filters Low pass filter: First order low pass active filter, second order active filter model, second order low pass filter characteristics, Sallen-Key unity gain filter, Sallen-Key equal component filter, Higher order filters. High pass active filter. Band pass filter: single op-amp band pass filter, multistage band pass filter State variable filter. **Unit IV: Non Linear Circuits:** Logarithmic Amplifiers, Log/Antilog Modules, Precision Rectifier, Peak Detector, Sample and Hold Circuits. OP-AMP as Comparator, Schmitt Trigger, Square and Triangular Wave Generator, MonostableMultivibrator. IC Analog Multiplier applications. **Unit V: Voltage Regulators:** OP-AMP Regulators, IC Regulators, Fixed Voltage Regulators (78/79, XX), SMPS.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 561	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	N	Y
Course Title	**Robust Control**			
Course Coordinator				
Course objectives:	The subject aims to provide the student with • The introduction to modern robust control theory techniques for largescale uncertain multivariable systems. • The stability and performance, computer-aided tools for both system analysis and controller design.			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours			3	0
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Linear Robust Control
	Author	M. Green and David Limebeer
	Publisher	Dover Publications
	Edition	2012
Reference Book:		
1.	Title	Essentials of Robust Control
	Author	K. Zhou and John C. Doyle
	Publisher	Prentice Hall
	Edition	1997
2.		

Content	**Unit I: Modeling of Uncertain Systems:** Unstructured uncertainties; Parametric uncertainty; Linear Fractional Transformations; Structured uncertainties. **Unit II: Internal Stability and Performance Specifications:**

	Feedback structure; Well-posedness of feedback loop; Coprime factorization over RH_∞.; Feedback properties; Weighted H_2 and H_∞performance; selection of weighting functions; Bode's gain and phase relation; analyticity constraints. **Unit III: Balanced Model Reduction:** Lyapunov equation and inequalities; balanced realizations; Hankel operators; Model reduction- Limitations, balanced truncation. **Unit IV: Uncertainty and Robustness:** Model uncertainty; Small Gain Theorem; stability under unstructured uncertainties; Robust performance; skewed specifications. **Unit V: μ and μ synthesis:** Structured singular value; structured robust stability and performance; overview of μ synthesis; μ synthesis-D-K iteration method and μ-K iteration method. **Unit VI: H_2 and H_∞ control:** Regulator problem; LQR problem; Guaranteed stability margins of LQR; H_2 problem; stability margins of H_2 controllers; control problem; minimum entropy controller; GenralH_∞ solutions; H_2 and H_∞ integral control; H_∞ filtering; H_∞ controller reduction. **Unit VII: H_∞ Loop Shaping**: Robust stabilization of coprime factors; Loop shaping design; Normalised coprime factorization of discrete time plant; mixed optimization design method.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 562	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				Yes
Course Title	**Special Electrical Machines**			
Course Coordinator				
Course objectives:	The objectives of the course include the working principle and operation of permanent magnet, synchronous reluctance, Switched reluctance, linear induction and stepper motors.			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Power Electronics Control of AC Motors
	Author	Murphy J.M.D., Turnbull F.G.
	Publisher	John Wiley & Sons, Pergamon Press, New York
	Edition	1988
2.	Title	Brushless Permanent Magnet and Reluctance Motor Drives
	Author	Miller T.J.E
	publisher	Oxford Clarender Press
	Edition	1982
Reference Book:		
1. 1.	Title	Power Electronics & Variable Frequency Drives – Technology & Applications
	Author	Bose B.K.

		Publisher	Wiley-IEEE Press
		Edition	2001
2.		Title	Energy Efficient Electric Motors
		Author	Andreas J.C.
		Publisher	Wiley- Springer
		Edition	1982
Content	**Unit I: Introduction:** Review of adjustable speed drives, motor requirement for drives, induction motor and synchronous motor drives; Vector control and Field Oriented Control methods. **Unit II: Permanent- magnet Motors:** Permanent- magnet materials, characteristics, energy density and equivalent circuits, losses and efficiency of PM motors. Principle and construction of permanent magnet brushless dc motor drives (PMBDCM); Operation with sinusoidal, square and trapezoidal waves; Vector control of PM synchronous motor; Control strategies; Flux weakening operation; Modelling of drive; Converter topologies for PMBDCM drive. Sensor-less control of AC drives, parameter identification in PMBDCM and induction motor drive, speed and position estimation, parameter sensitivity; Robust motion control. **Unit III: Synchronous Reluctance Based Drive:** Principle and construction of synchronous reluctance based drive, operating condition and power factor of synchronous reluctance motors, constant power operation, PM reluctance motors. **Unit IV: Switched Reluctance Motors:** Principle, construction and operation of switched reluctance motors, torque developed, losses and efficiency; Design and application considerations **Unit V: Linear Induction Motors:** Principle, construction and operation of linear induction motors, Goodness factor, short stator and short rotor effect; High speed and low speed applications. **Unit VI: Stepper Motors:** Principle, construction and operation of stepper motors, variable reluctance and permanent magnet stepping motors, hybrid stepping motors, drive circuits.		
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course no: EEL 563	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				Yes
Course Title	**Applied Linear Algebra**			
Course Coordinator				
Course objectives:	This course gives the applications of linear algebra for engineering problems.			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
,	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Linear Algebra and its Applications
	Author	Gilbert Strang
	Publisher	Saunders College Publishers
	Edition	1988
2.	Title	Applied Linear Algebra and Matrix Analysis
	Author	Thomas S. Shores
	publisher	Springer
	Edition	2007
Reference Book:		
1 .	Title	Matrix and Linear Algebra
	Author	Datta Kanti B.
	Publisher	Oxford- Prentice Hall of India
	Edition	3rd edition 1999
2.	Title	Linear Algebra
	Author	Hoffman K. and Kunze Ray

	Publisher	Oxford- Prentice Hall of India
	Edition	2007
Content	**Unit I: Linear systems of equations:** Gaussian elimination, matrix algebra, applications of matrix arithmetic Matrix Inverses Determinants, Tensor Product. **Unit II: Vector Spaces:** definitions and basic concepts, subspaces, linear combinations, subspaces associated with matrices and operators, bases and dimension, linear systems, change of basis and linear operators, standard norm and inner product, applications of norm and inner product, unitary and orthogonal matrices. **Unit III: Eigen value Problem:** definitions and basic properties, similarity and diagonalization, applications to discrete dynamical systems, orthogonal diagonalization, singular value decomposition. **Unit IV: Abstract Spaces:** normed linear spaces, inner product spaces, gram-schmidt algorithm, operator norms.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EEL 564	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				Yes
Course Title	**Advanced Control Systems**			
Course Coordinator				
Course objectives:	To familiarize students with classical and modern control systems including non-linear systems.			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Linear System Theory and Design
	Author	C. T. Chen
	Publisher	Oxford University Press
	Edition	4th Edition
2.	Title	Linear Control Theory -The State Space Approach,
	Author	F. W. Fairman
	publisher	John Wiley & Sons,
	Edition	1998
Reference Book:		
1. 1.	Title	Linear System Theory
	Author	J. S. Hespanha
	Publisher	Princeton University Press
	Edition	

Content	**Unit I: Introduction to Systems:** Linear systems; LTI systems; Linearization; Discrete time systems. **Unit II: State space solutions and Realizations:** Solution of LTI equations; Equivalent state equations; Realizations; Solution of LTV equations; Time-varying realizations. **Unit III: Stability:** Input-output stability of LTI systems; Internal stability; Lyapunov theorem; Stability of LTV systems. **Unit IV: Controllability and Observability:** Controllability; Observability; Canonical decomposition; Conditions in Jordan-form equations; Discrete-time state equations; Controllability after sampling; LTV state equations. **Unit V: Minimal Realizations and Coprime Fractions:** Implications of coprimeness; Computing coprime fractions; Balanced realizations; Realizations from Markov parameters; Degree of transfer matrices; Minimal Realizations-Matrix case; Matrix polynomial fractions; Realization from matrix coprime fractions; Realization from matrix markov parameters. **Unit VI: State Feedback and State Estimators:** State feedback; Regulation and tracking; State estimators; Feedback from estimated states; State feedback-multivariable case; State estimators-multivariable case; Feedback from estimated states-multivariable case. **Unit VII: Pole placement and Model Matching:** Unity feedback configuration-pole placement; Implementable transfer functions; Multivariable unity feedback systems; Multivariable model matching- Two parameter configuration.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 565	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				Yes
Course Title	**FPGA Based Digital Design Techniques**			
Course Coordinator				
Course objectives:	The objective of this course is to introduce Logic design principles, programming fundamentals of hardware descriptive language and design with Field Programmable Gate Arrays			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Digital Design
	Author	Mano M. M. and Ciletti M. D.
	Publisher	Pearson Education
	Edition	4th Ed., 2008
2.	Title	Digital Design – Principles and Practices
	Author	Wakerly J. F.
	publisher	Pearson Education
	Edition	4th Ed., 2008
3.	Title	VHDL Programming by Example
	Author	Perry D. L.
	Publisher	Tata McGraw-Hill Publishing Company Limited
	Edition	4th Ed.,2008
Reference Book:		
1.	Title	Fundamentals of Digital Logic with VHDL Design
	Author	Brown S. and Vranesic Z.
	Publisher	Tata McGraw-Hill Publishing Company Limited
	Edition	2nd Ed., 2008

2.		Title	Circuit design with VHDL
		Author	Pedroni V. A.
		Publisher	Prentice Hall of India Private Limited
		Edition	2008
Content	**Unit I: Review of Logic Design Fundamentals:** Combinational logic, hazards in combinational networks, Mealy and Moore sequential circuit design, sequential circuit timing. **Unit II: VHDL:** Introduction, VHDL terms, code structure, data types, operators and attributes, concurrent and sequential code, variables and signals, subprograms and procedures, packages and libraries, pre-defined attributes. **Unit III: VHDL Description of Combinational and Sequential Circuits:** Multiplexers, decoders, encoders, code converters, Flip-flops, registers, counters, clock synchronization. **Unit IV: Design of Programmable Logic Devices, Circuits and Memories:** Read-only memories, programmable logic arrays, programmable array logics, Serial adder, binary multiplier, multiplication of signed numbers, binary divider, VHDL models for memories and buses, simplified bus model. **Unit V: Design with Field Programmable Gate Arrays:** Introduction of FPGAs, designing with FPGAs and CPLDs, Testing combinational logic, testing sequential logic, scan testing.		
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%		

Course no: EEL 566	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				Yes
Course Title	**Optimal Control**			
Course Coordinator	To apply the knowledge and tools of optimal theory to Control Systems.			
Course objectives:				
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Optimal Control-An Introduction
	Author	Donald E. Kirk
	Publisher	Dover Publications
	Edition	
2.	Title	Optimal Control: Linear Quadratic Methods
	Author	B. D. O. Anderson and John B. Moore
	publisher	Dover Publications
	Edition	
Reference Book:		
1. 1.	Title	Optimal Control: An Introduction to the Theory and its Applications
	Author	M. Athans and Peter L. Falb
	Publisher	Dover Publications.
	Edition	

Content	**Unit I: Conditions for Optimality:** Ordinary minima; Ordinary minima with constraints; Variational approach to control problems; Minimum principle of Pontryagin; Sufficient conditions for optimality. **Unit II: Optimal Systems:** Minimum time problems; Minimum fuel problems; Minimum energy problems; Singular problems; Fixed and free boundary condition problems. **Unit III: Time-Optimal Systems:** Time optimal control of: Double integral plant, Plants with two time constants, Plants with N real poles, Harmonic oscillator, First order Nonlinear plant, Class of 2^{nd} order nonlinear systems. **Unit IV: Fuel-Optimal Systems:** Fuel optimal control of double integral plant; Minimization of a linear combination of time and fuel for: Double integral plant, Integral plus time constant plant and Nonlinear 2^{nd} order system. **Unit V: Optimal Linear System with Quadratic Criteria:** State regulator problem; Output regulator system; Tracking problem.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: **EEL 611**	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				Yes
Course Title	**Electric Vehicles**			
Course Coordinator				
Course objectives:	The objective of this course is to introduce Electric Traction drive and calculations, power electronics – electrical machines & drives for HEV (Hybrid Electric Vehicles)			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Fundamental of Electrical Drives
	Author	Dubey G.K.
	Publisher	Narosa Publishing House, New Delhi.
	Edition	2005
2.	Title	Power Electronics and Motor Control
	Author	Shepherd W., Halley L.N., Liang D.T.W.
	Publisher	Cambridge Printing Press, UK
	Edition	1990
3.	Title	Railway Traction-The Principles of Mechanical and Electrical Railway Traction

	Author	Andrews H.I.
	Publisher	Elsevier, Prentice Hall
	Edition	2004
Reference Book:		
1.	Title	Power Sources , Models, Sustanability, Infrstructure and the market
	Author	Pistooa G.
	Publisher	Elsevier
	Edition	2008
2.	Title	Power Electronics & Variable Frequency Drives – Technology & Applications
	Author	Bose B.K.
	Publisher	IEEE Press, Standard Publisher Distributors, Delhi
	Edition	2001
3.	Title	Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives
	Author	Mi Chris, Masrur A., and Gao D.W
	Publisher	Wiley
	Edition	2011

Content

Unit I: Electrical Traction:

General features of electric traction, mainline and suburban trains, nature of load and motor for traction.

Mechanism of train movement, duty cycle, torque sharing between motors, driving axle code. Calculation of tractive effort, drive rating and energy consumption, specific emery consumption.

Electrical motors for traction, starting and speed control of sc motors and ac motors.

Diesel electric traction, characteristics of diesel engine.

AC drives in Electric Traction, comparative advantages over dc drives.

Unit II: Hybrid Electric Vehicles:

Introduction: History of hybrid vehicles, architectures of HEVs, series and parallel HEVs, complex HEVs.

Power Electronics in HEVs: Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter,current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.

Electric Machines and Drives in HEVs: Induction motor drives, Field oriented control of induction machines; Permanent magnet motor drives; Switched

	reluctance motors; Doubly salient permanent magnet machines.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 612	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				Yes
Course Title	**AI Techniques and Applications**			
Course Coordinator				
Course objectives:	The objective of this course is to introduce definition, problem solving methods for Artificial Intelligence, Fuzzy Logic, ANNs (Artificial Neural Networks), Evolutionary techniques and hybrid systems			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Artificial Intelligence and Intelligent Systems
	Author	NP Padhy
	Publisher	Oxford University Press
	Edition	
2.	Title	Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications
	Author	Rajasekaran S. and Pai G.A.V.
	publisher	PHI New Delhi.
	Edition	
3.	Title	Genetic Algorithms in Search Optimization & Machine Learning
	Author	Goldberg D.E.
	Publisher	Addition Wesley Co., New York
	Edition	
Reference Book:		

1.	Title	Neural Fuzzy Systems
	Author	Lin C. and Lee G.
	Publisher	Prentice Hall International Inc.
	Edition	
2.	Title	Neural Networks & Fuzzy Systems A dynamical systems approach to machine intelligence
	Author	Kosko B.
	Publisher	Prentice Hall of India
	Edition	
3.	Title	Power System stability
	Author	Taylor C.W.
	Publisher	Mc-Graw Hill,New York
	Edition	

Content	**Unit I:** Artificial Intelligence: Definition, problem solving methods, searching techniques, knowledge representation, reasoning methods, predicate logic, predicate calculus, multivalue logic. **Unit II:** Fuzzy Logic: Concepts, fuzzy relations, membership functions, matrix representation, de-fuzzification methods **Unit III:** Artificial Neural Network: Introduction, multi-layer feed forward networks, back propagation algorithms, radial basis function and recurrent networks**.** **Unit IV:** Evolutionary Techniques: Introduction and concepts of genetic algorithms and evolutionary programming **Unit V:** Hybrid Systems: Introduction and Algorithms for Neuro-Fuzzy, Neuro-Genetic, Genetic-Fuzzy systems
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 613	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course				Yes
Course Title	**Energy Storage Devices**			
Course Coordinator				
Course objectives:	The objective of this course is exhaustive study and analysis of various energy storage devices such as Battery, valve regulated lead acid batteries, ultra capacitors/super capacitors. The course also deals with Power Electronics for charge control.			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:

1.	Title	Valve-regulated Lead–Acid Batteries
	Author	D.A.J. Rand, P.T. Moseley, J. Garche and C.D. Parker
	Publisher	Elesevier ,
	Edition	2004
2.	Title	Energy Storage Systems in Electronics-New Trends in Electrochemical Technology
	Author	Tetsuya Osaka, Madhav Datta
	publisher	CRC Press
	Edition	2000
3.	Title	Fuel Cell Systems Explained
	Author	James Larminie, Andrew Dicks, Wiley-Blackwell
	Publisher	Wiley

	Edition	2nd edition, 2003
Reference Book:		
1.	Title	Industrial Applications of Batteries from Cars to Aerospace and Energy Storage
	Author	M. Broussely, G. Pistoia
	Publisher	Elsevier
	Edition	2007
2.	Title	Lithium Batteries – Science and Technology
	Author	G.A. Nazri and G. Pistoia
	Publisher	Kluwer Academic Publishers
	Edition	2004

Content

Unit I: Battery

Introduction, energy storage parameters, lead–acid batteries constructional features, battery charge–discharge cycles operating limits and parameters, maintenance, sizing, types, applications, performance measurement, charging and discharging of a battery, storage density, energy density, and safety issues in lead-acid, nickel-cadmium, zinc manganese dioxide batteries, modern batteries as zinc-air, nickel hydride, lithium battery, flow batteries.

Unit II: Valve Regulated Lead Acid Batteries

The valve-regulated battery, valve-regulated battery, heat management in lead–acid batteries, heat generation, heat dissipation, lead alloys for valve-regulated lead–acid batteries, hardening mechanism in lead–calcium alloys, aluminum addition, formation of structure of positive and negative active masses, manufacture of lead–acid battery plates, soaking and formation phenomena, positive-plate additives to enhance formation and battery performance, modeling the effects of additives, conductive additive, negative-plate additives, function of the separator in the VRLA battery, characteristics of absorptive glass materials, separator properties and function, separator materials, applications in automotive applications, telecommunications and UPS Applications, remote-area power-supply systems(RAPS), recovery and recycling of lead–acid batteries

Unit III: Ultra Capacitors/Super Capacitors:

Introduction, doublelayer ultra capacitors, high-energy ultra capacitors, rating, size and applications, super capacitors, basic components of super capacitors, several types of electrodes and electrolytes, electrode materials, high surface area activated carbons, metal oxide, conducting polymers, types of electrolyte, disadvantages, advantages of super capacitors, comparison with battery systems, applications in public transport vehicles, private vehicles, and consumer electronics, aspects of energy density, power density, price, and market.

Unit IV: Power Electronics for Charging Control

	Battery management systems, battery data acquisition, battery state-of-charge, control of charge and discharge, multiple battery systems, thermal management of batteries, safety management of batteries, charging techniques for VRLA batteries, constant-voltage charging, constant-current charging, constant voltage–constant current combinations, taper-current charging, pulsed-current charging, charging of VRLA products, oxygen cycle and saturation effects, overcharge processes, ac-dc and dc-dc converters, isolated converters, multi pulse converters, multilevel converters, P2 cell, resonant converters, protection circuits, charger design and calculation of losses.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 614	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
Type of course				Yes
Course Title	**Energy Auditing and Management**			
Course Coordinator				
Course objectives:	To impart knowledge to the students about current energy scenario, energy management, auditing and assessment.			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:

1.	Title	Handbook on Energy Audit and Environment Management
	Author	Y P Abbi and Shashank Jain,
	Publisher	TERI
	Edition	2006
2.	Title	Electric Energy Utilization And Conservation
	Author	Tripathy S.C
	publisher	Tata McGraw Hill,
	Edition	1991
3.	Title	Art and Science of Utilisation of Electrical Energy
	Author	Partab H.
	Publisher	Dhanpat Rai and Sons, New Delhi.
	Edition	1975
4.	Title	Energy-Efficient Electric Motors and Their

		Applications
	Author	Howard E. Jordan
	Publisher	Plenum Pub Corp
	Edition	2nd edition ,1994
Reference Book:		
1.	Title	Plant Engineers and Managers Guide to Energy Conservation
	Author	Albert Thumann, P.W.
	Publisher	Seventh Edition-TWI Press Inc, Terre Haute
	Edition	2007
2.	Title	Guide to Energy Management
	Author	Barney L. Capehart, Wayne C. Turner, William J. Kennedy
	Publisher	Fairmont Press
	Edition	6 edition -April 23, 2008
	Title	Industrial Energy Management: Principles and Applications
	Author	Giovanni Petrecca
	Publisher	The Kluwer international series -207
	Edition	1999

Content

Unit I: Objective: Understanding, analysis and application of electrical energy management-measurement and accounting techniques-consumption patterns- conservation methods-application in industrial cases.

Unit II: System approach and End use approach to efficient use of Electricity; Electricity tariff types; Energy auditing: Types and objectives-audit instruments-ECO assessment and Economic methods-specific energy analysis-Minimum energy paths-consumption models-Case study.

Unit III: Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis- Energy efficient /high efficient Motors-Case study; Load Matching and selection of motors.

Unit IV: Variable speed drives; Pumps and Fans-Efficient Control strategies-Optimal selection and sizing -Optimal operation and Storage; Case study

Unit V: Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, case study.

Unit VI: Reactive Power management- Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-Placement-Maintenance, case study.

Unit VII: Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load scheduling-case study.

Unit VIII: Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case

	study. **Unit IX:** Cogeneration- Types and Schemes-Optimal operation of cogeneration plants-case study;Electric loads of Air conditioning & Refrigeration-Energy conservation measures- Cool storage. Types-Optimal operation-case study; Electric water heating-Gysers-Solar Water Heaters-Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls- software-EMS
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 615	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
Type of course	N	N	N	Y
Course Title	**Telemetry Systems**			
Course Coordinator				
Course objectives:	The aim of this course is to understand • The principles of telemetry, multiplexing, modem protocols, and antenna theory for practical applications • The use of fibre optics in communication • The use of industrial telemetry.			
POs				

Semester	Autumn:		Spring	
	Lecture	Tutorial	Practical	Credits
Contact Hours	3	0	0	3
Prerequisite course code as per proposed course numbers				
Prerequisite credits				
Equivalent course codes as per proposed course and old course				
Overlap course codes as per proposed course numbers				

Text Books:		
1.	Title	Telemetry Principle
	Author	D Patranabis
	Publisher	TMH
	Edition	1st Edition
2.	Title	Principles of Communication
	Author	Taub and Schilling
	Publisher	Tata McGraw Hill
	Edition	Third Edition
Reference Book:		
1.	Title	Telemetry Systems Engineering
	Author	Frank Carden, Russell Jedlicka, Robert Henry
	Publisher	Artech House
	Edition	2002

Content	**Unit I: Introduction to Telemetry Principles:** Basic System, Classification, Non electrical telemetry systems, Voltage and current Telemetry systems, Frequency Telemetering, Power line carrier Communication. **Unit II: Multiplexed System:** Multiplexed System: Frequency Division Multiplex System FDM, IRIG Standards, FM circuits, Phase Modulation Circuits, Receiving end, Phase Locked Local Loop, Mixers. Time Division Multiplexed System – TDM/PAM system, PAM/ PM systems, TDM- PCM System, Digital Multiplexer, PCM Reception, coding for varying level, DPCM, Standards. **Unit III: Transmitter and Receiver:** Transmitters, Transmission Techniques, Inter stage Coupling, Receiver Antennas: The Ideal structure, dipoles, arrays, current distribution and design consideration, Microwave Antennas, Transmitter and Receiver selection, Modems Introduction, QAM, modem protocol. **Unit IV: Filters:** Polynomial, Filters, Active RC Filters, Universal Filter Circuits, Switched Capacitor Filters, Digital Filters Basics of Satellite and Fiber Optic Telemetry Data Acquisition Systems (DAS), microprocessor based DAS, Remote Control. **Unit V: Industrial Telemetry:** History of Industrial Telemetry, Telemetry Versus SCADA Versus Process Control, Modern Industrial Applications, Petroleum Industries, Power Utility Industry, Railroad Transportation, Fire-Life-Safety Systems, Intelligent Transportation Systems, Telephone and Cable Network Monitoring, Industrial Communications Equipment, Temperature Measuring Devices, Fluid and Gas Flow Measuring Devices, Fluid Level Measuring Devices, Other Measuring Devices, Control Output Devices, Remote Control and Monitoring Computer Systems.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%