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SEMESTER III

ELECTIVE IV

Course No.	Course Name	L-T-P-Credits
08EE7211 (A)	**SPECIAL ELECTRICAL MACHINES AND DRIVES**	**3-0-0-3**

Course Objective:

To introduce special types of electric machines and their controls for special applications.

Syllabus:

Stepper motor, switched Reluctance motor, Permanent Magnet brushless DC motor, Permanent magnet synchronous motors, their dynamic characteristics and control.

Expected outcome

The students will be able to analyse special electric machines and their control for special applications.

References

1. Kenjo T, Sugawara A, Stepping Motors and Their Microprocessor Control, Clarendon Press, Oxford
2. Miller T J E, Switched Reluctance Motor and Their Control, Clarendon Press, Oxford
3. Miller T J E, Brushless Permanent Magnet and Reluctance Motor Drives, Clarendon Press, Oxford
4. B K Bose, Modern Power Electronics & AC drives, Pearson Education
5. Kenjo T, Power Electronics for the Microprocessor Age, Oxford University Press
6. Ali Emadi (Ed), Handbook of Automotive Power Electronics and Motor Drives, CRC Press
7. R Krishnan, Electric Motor Drives – Modeling, Analysis and Control, PHI
8. H A Toliyat, S Campbell, DSP Based Electro Mechanical Motion Control, CRC Press

Course Plan

Module	*Contents*	*Hours*	*% marks for semester exam*
I	Stepping Motors, Constructional features, principle of operation, modes of excitation, single phase stepping motors, torque production in variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor, microprocessor based controller	***9***	***15***
II	Switched Reluctance Motors Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control. Microprocessor based controller. Sensor less control.	***7***	***15***
FIRST INTERNAL EXAM			
III	Synchronous Reluctance Motors Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque – Phasor diagram, motor characteristics.	***7***	***15***

IV	Permanent Magnet Brushless DC Motors Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors.	***7***	***15***
SECOND INTERNAL EXAM			
V	Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller. Sensorless control.	***7***	***20***
VI	Permanent Magnet Synchronous Motors Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes - Sensor less control.	***9***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	**Course Name**	**L-T-P-Credits**
08EE7211 (B)	**INDUSTRIAL INSTRUMENTATION**	**3-0-0-3**

Course Objective:

- To make the students aware of the different transducers used in industry and signal conditioning .
- To familiarize the process control elements and their control characteristics .

Syllabus:

Signal conditioning, analog and digital, Final Control Element, Actuators, Signal Conditioning of Transducer, Controller Principles, pneumatic controllers, Control Loop Characteristics,

Expected outcome

The students will be able to analyse the control characteristics of different process control elements and select them for various applications.

References

1. Curtis D. Johnson, Process Control Instrumentation Technology, Pearson Education
   Curtis D. Johnson, Microprocessors in Process Control, PHI
2. George Stephanopoulis, Chemical Process Control
3. Caughner, Process Analysis and Control
4. Deshpande and Ash, Elements of computer process control of Industrial processes, ISA
5. Jayantha K. Paul, Real- Time microcomputer control of Industrial processes, Kluwer Publications, Netherlands
6. S. K. Singh, Computer Aided Process Control, PHI
7. Dale E. Seborg, Thomas F. Edgar, Duncan A. Mekkichamp, Process Dynamics and Control, Wiley India

Course Plan

Module	***Contents***	***Hours***	***% marks for semester exam***
I	Signal Conditioning – Analog – Digital - Signal conversions - Process Control Principles - Identification of elements, block diagram, the loop, control system evaluation stability, regulation, evaluation criteria, and cyclic response.	***9***	***15***
II	Final Control Element: Final control operation, signal conversions, analog electrical signal, digital electrical signals, Direct action – pneumatic signals.	***7***	***15***
FIRST INTERNAL EXAM			
III	Actuators – electrical actuators, pneumatic actuators, control elements – fluid valves. Signal Conditioning of Transducers- Temperature Transducers - flow transducers.	***7***	***15***
IV	Controller Principles - Process characteristics, control system parameters, controller modes, discontinuous controller modes, continuous controller modes, composite controller modes.	***7***	***15***

SECOND INTERNAL EXAM			
V	Analog Controllers - Electronic controller – Direct action, reverse action, proportional mode, integral mode, derivative mode, composite controller modes - Pneumatic controllers – implementation of PI, PID, PD - Design consideration.	***8***	***20***
VI	Control Loop Characteristics: Control system configurations, cascade control, multivariable control, feed forward control, Split range control, inferential control, Adaptive control, control system quality – loop disturbance, optimum control, measure of quality, Stability, process loop tuning	***8***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	**Course Name**	**L-T-P-Credits**
08EE7211 (C)	**NONLINEAR CONTROL SYSTEMS**	**3-0-0-3**

Course Objective:

To familiarize

- the characteristics and analysis of nonlinear systems using phase plane and describing function method
- the concept of Lyapunov stability and linearization procedures
- the advanced control techniques: sliding mode, back stepping

Syllabus:

Characteristics of nonlinear systems, describing functions, Stability of Nonlinear Systems using Lypunov methods, Analysis of feedback systems-Circle Criterion - Popov Criterion - simultaneous Lyapunov functions, Sliding Mode Control, Lyapunov Redesign

Expected outcome

The students will be able to analyze and check the stability of non liner systems.

References

1. Hassan K Khalil, Nonlinear Systems, Prentice - Hall International (UK) 1996

2. Slotine & W.LI, Applied Nonlinear Control Prentice Hall, Engloe wood NewJersey 1991

3. A Isidori, Nonlinear Control systems Springer verlag New york 1995

4. C Edwards, S Spurgeon, Sliding mode Control, Theory and Applications, CRC Press, 1998.
5. V. Utkin, J Guldner,J Shi, Sliding Mode Control in Electro Mechanical Systems, CRC Press, 2009.

Course Plan

Module	*Contents*	*Hours*	*% marks for semester exam*
I	Characteristics of nonlinear systems - classification of equilibrium points - limit cycles - analysis of systems with piecewise constant inputs using phase plane analysis - describing function of standard nonlinearities- study of limit cycles (amplitude and frequency) using Single input Describing Function(SIDF).	***8***	***15***
II	Stability of Nonlinear Systems- Lyapunov stability - local stability - local linearization and stability in the small - Direct method of Lyapunov - generation of Lyapunov function for linear and nonlinear systems – variable gradient method.	***7***	***15***
FIRST INTERNAL EXAM			
III	Centre manifold theorem - region of attraction - Invariance theorems - Input output stability - L stability - L stability of state models - L2 stability-	***7***	***15***

	Lyapunov based design		
IV	Analysis of feedback systems-Circle Criterion - Popov Criterion - simultaneous Lyapunov functions - Feedback linearization - stabilization - regulation via integral control - gain scheduling - input state linearization - input output linearization - state feedback control - stabilization - tracking - integral control	***9***	***15***
SECOND INTERNAL EXAM			
V	Sliding Mode Control- Concept of variable - structure controller and sliding control, reaching condition and reaching mode, existence condition- implementation of switching control laws.	***8***	***20***
VI	Reduction of chattering in sliding mode, Lyapunov Redesign: Stabilization-Nonlinear Damping, Back stepping Control	***8***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

ELECTIVE V

Course No.	Course Name	L-T-P-Credits
08EE7221 (A)	**SOFT COMPUTING TECHNIQUES**	**3-0-0-3**

Course Objective:

To acquaint the students with soft computing methodologies such as neural networks, fuzzy logic,

genetic algorithms and hybrid algorithms and enable the students to implement real time intelligent and adaptive systems.

Syllabus:

Introduction to Fuzzy logic, Fuzzification, Defuzzification methods, Artificial Neural Networks concepts, Fundamentals of genetic algorithms and hybrid systems.

Expected outcome

The students will be able to apply soft computing methodologies to implement real time intelligent and adaptive systems.

References

1. S.Rajasekharan, G.A.Vijayalakshmi Pai, Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice Hall India.
2. S.N.Sivanandam, S.N.Deepa, Principles of Soft Computing, Wiley India.
3. Timothy J Ross, Fuzzy logic with Engineering Applications, McGraw Hill ,New York.
4. S.Haykins, Neural Networks a Comprehensive foundation, Pearson Education.
5. D.E.Goldberg, Genetic Algorithms in Search Optimisation and Machine Learning, Pearson Education.
6. Recent Literature.

Course Plan

Module	*Contents*	*Hours*	*% marks for semester exam*
I	Introduction to Fuzzy logic: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations- Operations on Fuzzy relations-Properties of Fuzzy relations-Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification- Deffuzzification methods-Fuzzy logic controller(Block Diagram)	*7*	*15*
II	Artificial Neural Networks: Basic concepts-Neural network Architectures-Single layer feed forward network- Multilayer feed forward network.	*7*	*15*
FIRST INTERNAL EXAM			
III	Recurrent Networks-Characteristics of Neural Networks-Learning methods. Perceptron networks-Back Propagation networks-Radial base function network-Hopfield network- Kohonen Self	*7*	*15*

IV	Fundamentals of genetic algorithms: Basic concepts- working principle – encoding – different methods – Fitness function – reproduction- different methods. Genetic modelling-inheritance-Crossover mutation- Convergence of genetic algorithm.	***8***	***15***
SECOND INTERNAL EXAM			
V	Hybrid systems: Neural network, fuzzy logic and genetic algorithm hybrids – Neuro fuzzy hybrids-neuro genetic hybrids-Fuzzy genetic hybrids	***8***	***20***
VI	Genetic algorithm based back propagation network- Fuzzy back propagation networks -fuzzy logic controlled genetic algorithms.	***8***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	**Course Name**	**L-T-P-Credits**
08EE7221 (B)	**Design of Power Electronics System**	**3-0-0-3**

Course Objective:

To enable the students to design control circuits and cooling system for power electronics based system.

Syllabus:

Design of gate and base drive circuits, snubber circuits and het sink design concepts, Demonstration Design.

Expected outcome

The students can design the control and cooling circuits for the power electronic circuits.

References

1.Ned Mohan, Tore M. Undeland and William P.Riobbins, " Power Electronics—Converters, Applications and Design" Third Edition, John Wiley and Sons. Inc2014

2.Muhammad H. Rashid, " Power Electronics, Circuits, Devices and Application"' Third Edition, Prentice Hall of India Private Limited, 2004

3.Joseph Vithayathil, " Power Electronics-Principle and Applications'' , Tata McGraw Hill Education Pvt Ltd, 2010.

4. Barry W. Williams, "Principles of Elecments of Power Electronics Deviceses, Drivers, Applications and Passive Components", Barry W. Williams, 2006.

5.Daniel W. Hart, "Power Electronics", Tata McGraw Hill, 2011.

Course Plan

Module	*Contents*	*Hours*	*% marks for semester exam*
I	Design of Gate and Base Drive Circuits: Design consideration, dc – coupled drive circuits isolated drive circuits, cascade-connected drive circuits Thyristor drive circuits power device protection in drive circuits layout considerations.	***8***	***15***
II	Snubber circuits: Function and type of Snubber circuits, diode snubbers thyristor snubber circuits, Transistor snubber circuits	***7***	***15***
FIRST INTERNAL EXAM			
III	Turn off and turn-on snubber, overvoltage snubber, snubber for bridge circuit configurations, GTO snubber considerations.	***8***	***15***
IV	Cooling and Design of heat sinks: Control of device temperature, heat transfer by conduction, heat sinks,heat transfer by radiation and	8	***15***

	convection		
SECOND INTERNAL EXAM			
V	Demonstration Design: Typical specification of power converters , EMI and layout fundamentals, design of power circuits to meet specification	***7***	***20***
VI	Design of resonant inverters, switch mode converter, single phase ac-dc inverter.	***7***	***20***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	**Course Name**	**L-T-P-Credits**
08EE7221 (C)	**RENEWABLE ENERGY TECHNOLOGIES**	**3-0-0-3**

Course Objective:

To have an understanding of various commercial renewable energy sources and method of conversion to electric energy.

Syllabus:

Renewable energy utilization, Wind energy, Solar energy and other renewable energy technologies

Expected outcome

The students will be able to design and model power electronic circuits for efficient conversion of energy in renewable energy technologies.

References

1. Thomas B Johansson , "Renewable Energy: "Sources for Fuels and Electricity", Island Press, Washington, 1993 .
2. John W Twidell and A D Weir , " Renewable Energy Sources",ELBS,1986.
3. N K Bansal, M Kleeman and M Mellis , "Renewable Energy Resources and conversion Technology " , Tata McGraw Hill , 1990.
4. S N Bhadra , D Kastha and S Banarji , " Wind Electrical Systems " ,Oxford University Press , 2005
5. Marcelo Godoy Simões and Felix A. Farret, "*Renewable Energy Systems: Design and*

Analysis with Induction Generators", CRC Press, ISBN 0849320313, 2004.
6. Ion Boldea, "*Variable Speed Generators"*, CRC Press, ISBN 0849357152, 2006.
7. S.N. Bhadra, D.Kastha and S.Banerje, "*Wind Electrical Systems"*, Oxford Uni Press, 2005.
8. Siegfried Heier, Rachel Waddington, "*Grid Integration of Wind Energy Conversion Systems"*, 2nd Edition', Wiley, 2006,
9. Freries LL , "*Wind Energy Conversion Systems"*, Prentice Hall, U.K., 1990
10. Chetan Singh Solanki, "*Solar Photovoltaics-Fundamentals, Technologies and Applications"*, PHI Learning Pvt. Ltd., New Delhi, 2011
11. Van Overstraeton and Mertens R.P., "*Physics, Technology and use of Photovoltaics"*, Adam Hilger, Bristol,1996.
12. John F.Walker & Jenkins. N , "*Wind Energy Technology*", John Wiley and sons, Chichester, UK, 1997.
13. Freries LL ,"*Wind Energy Conversion Systems"*, Prentice Hall, U.K., 1990

Course Plan

Module	***Contents***	***Hours***	***% marks for semester exam***
I	Renewable energy Sources: Renewable energy utilization in ancient times, classification of RE technologies – stand alone, hybrid and grid – connected; Recent developments in renewable energy sector- global and national energy policies	***8***	***15***
II	Wind energy – energy in the wind – aerodynamics - rotor types – forces developed by blades - Aerodynamic models – braking systems – tower - control and monitoring system	***7***	***15***
FIRST INTERNAL EXAM			
III	Design considerations-power curve - power speed characteristics. Choice of electrical generators Wind turbine generator systems-fixed speed induction generator-performance analysis	***7***	***15***
IV	Solar energy – Solar radiation and measurements; PV cell-principle, types and construction; modeling of PV cell, Maximum power tracking; SPV systems – stand alone and grid-connected.	8	***15***
SECOND INTERNAL EXAM			

V	Other renewable energy technologies; Biomass – gasifiers; small hydro-resource assessment, selection of turbines, Electronic load controller;	***7***	***15***
VI	Wave, Tidal, Ocean thermal and Geothermal energy systems – principles and technologies; Energy storage systems.	***8***	***10***

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 60 marks

Course No.	Course Name	L-T-P-Credits
08EE7231 (P)	**SEMINAR**	**0-0-2-2**

Course Objective:

To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him self esteem and courage that are essential for an engineer.

Expected outcome

The students will develop confidence to face the audience and present their ideas on a technical topic**.**

Individual students are required to choose a topic of their interest from power electronics and drive related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in power electronics) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

Course No.	Course Name	L-T-P-Credits
08EE7241 (P)	**MAIN PROJECT PHASE I**	**0-0-12-6**

Course Objective:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project/experimental project and/or computer simulation project on any of the topics in power electronics/drives related topics. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to carry out their main project outside the parent institute, subject to the conditions specified in the MTech regulations.

The student is required to undertake the Main project phase 1 during the third semester and the same is continued in the 4thsemester (Phase 2). Phase 1 consist of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

Project Evaluation:

Progress evaluation by the Project Supervisor: 20 Marks

Presentation and evaluation by the committee: 30 Marks

Total marks for the Project Phase 1: 50 Marks

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SEMESTER IV

Course No.	Course Name	L-T-P-Credits
08EE7212 (P)	**MAIN PROJECT PHASE II**	**0-0-21-12**