ARAB ACADEMY FOR SCIENCE, TECHNOLOGY AND MARITIME TRANSPORT

COLLEGE OF ENGINEERING AND TECHNOLOGY

(GRADUATE STUDIES)

Master of Science Programs

STATUS REPORT

ALEXANDRIA

2012

ELECTRICAL AND COMPUTER CONTROL ENGINEERING

M.Sc. Programs

OVERVIEW

With electrification projects forging ahead in developing countries and peak demand forecast doubling every ten years, projects of super grids emerged to link all Arab nations from Iraq in the east to Morocco in the west and across the continent from North Africa to South Africa with eventual interconnection with Europe. Consequently, there is a pressing need for experts in research areas of generation, transmission, distribution, and utilization of electrical power.

On the other side, the fast development of sensors, actuators, Programmable logic controllers, Discrete control systems, power electronic devices and electric drive systems together with the rising need for highly complicated automatic control systems in military, industrial, commercial and electrical power systems areas raised in turn the need of control systems and electric drives research experts.

Program Detailed Structure

M.Sc. Programs

PRE-MASTER'S COURSES:

Course Code	Course Title	Credit Hours
EE 511	Discrete Control Systems	0
EE 512	Automated Industrial Systems (I)	0
EE 514	Robotics	0
EE 543	Electrical Power Distribution	0
EE 544	Power Systems (3)	0
EE 522	Electrical Drives (2)	0
Subtotal		**0**

CORE COURSES:

Course Code	Course Title	Credit Hours
EE 703	Advanced Engineering Mathematics	3
EE 704	Digital Circuit Design	3
EE 705	Electrical Measurement systems	3
Subtotal	**3 Courses * 3 Credit Hours**	**9**

ELECTIVE COURSES:

Course Code	Course Title	Credit Hours
EE 700	Directed Studies	3

GROUP (I) : CONTROL ELECTIVE COURSES

Course Code	Course Title	Credit Hours
EE 712	Linear Control systems	3
EE 713	Digital control Systems	3
EE 714	System Identification and Adaptive Control	3
EE 715	Optimal Control	3
EE 716	Fuzzy Systems	3
EE 717	Neural Networks and Neurocontrol	3
EE 718	Process Control	3
EE 719	Intelligent Control Systems	3

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GROUP (II) : POWER AND MACHINES ELECTIVE COURSES

Course Code	Course Title	Credit Hours
EE 721	Dynamics of Electrical Machines	3
EE 722	Computer–Aided Analysis of Electrical Machines	3
EE 723	Advanced Analysis and Design of Electric Motors	3
EE 724	Electrical Drives (3)	3
EE 725	Power Electronics (3)	3
EE 726	Vector Control of Electrical Drives	3
EE 727	Advanced Electrical Machines	3
EE 728	Industrial Power Conversion systems	3
EE 729	Generalized Theory of Electrical Machines	3
EE 740	Transients in Power Systems	3
EE 741	HVDC Power Transmission	3
EE 742	Electrical Insulation Engineering	3
EE 743	Power System Reliability	3
EE 744	Reactive Control in Electrical Power Systems	3
EE 745	Power System Control and Stability	3
EE 746	Computer Control of Power System	3
EE 747	Solid State Relays and their Applications	3
EE 748	Power System Analysis	3
EE 749	Renewable Energy Systems	3
Elective Subtotal	**5 Courses * 3 Credit Hours**	**15**

RESEARCH THESIS:

Course Code	Course Title	Credit Hours
EE 701	Master's Research Thesis (Part 1)	6
EE 702	Master's Research Thesis (Part 2)	6
Subtotal	**2 Parts * 6 Credit Hours**	**12**

Total	**36**

Courses

DETAILED STRUCTURE

Course Code : EE 703

Course Title : Advanced Engineering Mathematics

Credit Hours : 3

Course Description

Probability theory and stochastic models. Probability and random variables, probability distributions and densities. Conditional probability and densities. Functions of random variable. Expectations and moments of random variables Conditional expectations. Gaussian random vectors, linear operators of Gaussian random variables. Estimation with static linear Gaussian system models. Markov chains. Stochastic process and linear dynamic system models. Error analysis and computer related problems. Numerical Methods. Numerical methods in matrix algebra. Curve fitting. Optimization techniques.

Course Objectives

The student should become acquainted with:

- Various methodologies for solving mathematical problems related to stochastic processes, numerical methods, curve fitting and optimization.

Course Topics

- Probability theory and stochastic models
- Probability and random variables
- Probability distributions and densities
- Conditional probability and densities
- Functions of random variable
- Expectations and moments of random variables
- Conditional expectations
- Gaussian random vectors
- Linear operators of Gaussian random variables
- Estimation with static linear Gaussian system models
- Markov chains
- Stochastic process and linear dynamic system models
- Error analysis and computer related problems
- Numerical Methods
- Numerical methods in matrix algebra
- Curve fitting
- Optimization techniques

References

- R. E. Walpole, "*Probability and Statistics for Engineers and Scientists*", Pearson Education. N.J., 2007.
- S. Chappa and Canale, "*Numerical Methods for Engineers with Software and Programming Applications*", McGraw-Hill, London, 2002.

Course Code : **EE 704**

Course Title : **Digital Circuit Design**

Credit Hours : **3**

Course Description

Data Conversion: Data domain, digitalization. A/D and D/A conversion. Real time data processing: peripheral adaptors (synchronous and asynchronous). Inputs and output operations. Addressable switches. Data storage. Microprocessor based systems: sequence control; three term controllers; switching implementation motor position and speed control.

Course Objectives

The student should be able to:

- Know how the data is converted and digitalized.
- Learn methods of real time data processing and peripheral adaptors (synchronous and asynchronous)
- Deal with inputs and output operations, addressable switches and data storage.
- Microprocessor implementation in motor position and speed control.

Course Topics

- Data Conversion:
  - Data domain
  - Digitalization
- A/D and D/A conversion
- Real time data processing
- Peripheral adaptors:
  - synchronous
  - asynchronous
- Input and output operations
- Addressable switches
- Data storage
- Microprocessor based systems:
  - sequence control
  - three term controllers
  - switching implementation motor position and speed control

References

- F. Halsall and P. F. Lister, *'Microprocessor Fundamentals'*, UCL press 1993.
- A. P. Godse, *'Advanced Microprocessor and Microcontroller'*, Technical Publications Pune, 2004.

Course Code : **EE 705**

Course Title : **Electrical Measurement Systems**

Credit Hours : **3**

Course Description

Introduction, discrete event sensors, proximity sensors, photoelectric sensors, limit switches, fiber optics in instrumentation, single mode sensors, multi mode sensors, fiber optic magneto meter, fiber sensor design consideration, signal processing and transmission, signal amplification, signal attenuation, signal linearization, signal filtering, signal manipulation, sources of noise, measuring noise, noise reduction techniques.

Course Objectives

The student should be able to:

- Present different sensing element to different physical quantities.
- Update their knowledge of sensing elements and different components of instrumentation systems.

Course Topics

- Discrete event sensors
- Proximity sensors
- Photoelectric sensors
- Limit switches
- Fiber optics in instrumentation
- Single mode sensors
- Multi mode sensors
- Fiber optic magnetometer
- Fiber sensor design consideration
- Signal processing and transmission
- Signal amplification, signal attenuation
- Signal linearization, signal filtering, signal manipulation
- Sources of noise
- Measuring noise
- Noise reduction techniques.

References

- John P. Bently, "*Principles of measurement systems*, Longman Group Limited, UK, 1995.
- David E. Johnson and John L. Hilburn, "*Rapid practical Designs of Active Filters,* Wiley, New York, 1989.
- *Instrumentation Reference Book*, Walt Boyes, 3rd Edition, 2003

Course Code : **EE 712**

Course Title : **Linear Control System**

Credit Hours : **3**

Course Description

Review of SISO systems. Multivariable systems time varying systems. Controllability and observability, state variable feedback pole placement. System observer. Large scale systems. Introduction to optimum control Application.

Course Objectives

The student should be able to:

- Generalize the knowledge of students in the field of linear systems.
- Deal with linear multivariable systems and to get through practical models from the analysis and design point of view.

Course Topics

- Review of SISO systems
- Multivariable systems time varying systems
- Controllability and observability
- State variable feedback pole placement.
- System observer
- Large scale systems
- Introduction to optimum control application

References

- C.T. Chen. *Linear system theory and Design*, Oxford University Publisher, 1999.
- J.J. D'AZZO. and C. Houpis "*Linear control system analysis and design*", McGraw-Hill, 1995.
- I. Postethwaite and S. Skoestad, "*Multivariable Feedback Control: Analysis and Design*", Wiley, Chichester, 2005.

Course Code : **EE 713**

Course Title : **Digital Control Systems**

Credit Hours : **3**

Course Description

Review of systems analysis using the z-transform. Discrete system representation and modeling. State space representation. Controllability and observability. Observers. Controllers in discrete and digital forms.

Course Objectives

The student should be able to:

- Define digital system and its performance.
- Design, analyze and use controllers in discrete and digital forms.

Course Topics

- Review of systems analysis using the Z-transform
- Discrete system representation and modeling
- State space representation
- Controllability and observability
- Observers
- Controllers in discrete and digital forms

References

- Gene F. Franklin, J. D. Powell, "*Digital Control of Dynamic Systems*", 3rd Edition, 2008.
- B.C. Kou "*Digital Control Systems* ", Hotz Sanders, 1992.
- C.T. Chen, "*Analog and Digital Control System Design*", Saunders College Pb., 1992.
- C. Phillips, "*Digital Control System Analysis and Design*", Prentice Hall, 1990.

Course Code : **EE 714**

Course Title : **System Identification and Adaptive Control**

Credit Hours : **3**

Course Description

Statistical and optimization fundamentals. Impulse response identification. Parameter estimation. Frequency response estimation. Experimental methods. Correlation technique. Regression technique. Quasi-linearization method. Adaptive systems. Model reference adaptive systems. Self tuning regulators. Robust adaptive control.

Course Objectives

The student should be able to:

- Apply different methods of systems identification to control systems.
- Learn what adaptive control is, and how it can be applied.

Course Topics

- Statistical and optimization fundamentals
- Impulse response identification
- Parameter estimation
- Frequency response estimation
- Experimental methods
- Correlation technique
- Regression technique
- Quasi-linearization method
- Adaptive systems
- Model reference adaptive systems
- Self tuning regulators
- Robust adaptive control
- Gain Scheduling

References

- M.S. Santina, A.R. Stabberud and G.H. Hostetter, "*Digital Control System Design*", Saunders College Pub., 1994
- G.F. Franklin, I.D. Powell and M. Workman, "*Digital Control of Dynamic Systems*", Addison Wesley, 1998
- Benjamin C. Kuo, "*Digital Control Systems*", Saunder College Publishing, 1992
- C.L. Philip, "*Digital Control System Analysis and Design*", Prentice Hall Inc, 1990
- F. Nekoogar and G. Moriarty, "*Digital Control Using Digital Signal Processing*", Prentice Hall 1996

Course Code : **EE 715**

Course Title : **Optimal Control**

Credit Hours : **3**

Course Description

Review of unconstrained optimal control problems. Constrained mathematical programming. Variation problems. Maximum principle. Computer methods in optimal control. Geometric optimization.

Course Objectives

The student should be able to:

- Learn and apply optimization techniques in control systems.
- Use computer to optimize the controller.

Course Topics

- Performance measure
- Review of unconstrained optimal control problems
- Constrained mathematical programming
- Variation problems
- Maximum principle
- Computer methods in optimal control
- Geometric optimization
- Linear Quadratic Regulator (LQR)
- Stability review of linear systems

References

- G. F. Lawler, "*Optimal Control Theory for Applications*", Springer-Verlag, N.Y., 2003.
- J. B. Burl, "*Linear Optimal Control: H_2 and H [Infinity] Methods*," Addison Wesley, California, 1999.
- D. E Kirk, "*Optimal Control Theory: An Introduction*", 2004.

Course Code : **EE 716**

Course Title : **Fuzzy Systems**

Credit Hours : **3**

Course Description

Elementary introduction to fuzzy sets. Basic operations on fuzzy sets. Fuzzy logic knowledge based versus classical models. Self Organizing Fuzzy Logic Control SOFLC. Approach of fuzzy control. The Approach of Mamdani. The approach of Takagi and Sugeno Design parameters of fuzzy controllers. Variable domains. Linguistic rules. Defuzzification process. Case studies.

Course Objectives

The student should be able to:

- Know new approaches in design of controllers, of control systems.
- Principle of Fuzzy concepts.
- Fuzzy controllers.
- Usage of Fuzzy controller.

Course Topics

- Elementary introduction to fuzzy sets
- Basic operations on fuzzy sets
- Fuzzy logic knowledge based versus classical models
- Self Organizing Fuzzy Logic Control SOFLC
- Approach of fuzzy control
- The Approach of Mamdani
- The approach of Takagi and Sugeno
- Design parameters of fuzzy controllers
- Variable domains
- Linguistic rules
- Defuzzification process
- Case studies

References

- R. Kruse, J. Gebhardt ad F. Klawonn, "*Foundations of Fuzzy Systems*", J. Wiley, 1994.
- RR. Yager and D.P. Filey, "*Essentials of Fuzzy Modeling and Control*", J. Wiley, 1994.
- Witold Perdryz, "*Fuzzy Control and Fuzzy Systems*", J. Wiley, 1993.
- R. Belohlarek, "Fuzzy *Relational Systems: Foundation and Principles*", 2002

Course Code : **EE 717**

Course Title : **Neural Networks and Neurocontrol**

Credit Hours : **3**

Course Description

Elementary biophysical background for signal propagation in natural and neural systems. Artificial Neural networks (ANN). Hopfield. Feed forward. Learning techniques of McCulloch and Pitts Model. Connectionist model. The random neural network model. Associative memory. Learning algorithm application to Control engineering.

Course Objectives

The student should be able to:

- Learn the graduate new techniques in control system
- Update the graduate an objective on neural networks and how it is applied in control system

Course Topics

- Elementary biophysical background for signal propagation in natural and neural systems
- Artificial Neural networks (ANN)
- Hopfield
- Feed forward
- Learning techniques of McCulloch and Pitts Model
- Connectionist model
- The random neural network model
- Associative memory
- Learning algorithm
- Application to Control engineering
- Self organized map
- Learning vector quantization radial bias

References

- R. Beale and T. Jackson, "*Neural computing: An introduction*", Institute of Physics Publishing, 1990.
- J. Hertz, A Krogh and R.G. Palmer, "*Introduction to the Theory of Neural Computation*", Addison Wesley, Redwood City, CA 1992.
- M. N. O Ravn, N. K. Hansen, "*Neural Networks for Modeling and Control of Dynamic Systems*", 2008

Course Code : **EE 718**

Course Title : **Process Control**

Credit Hours : **3**

Course Description

Mathematical modeling of chemical processes. Dynamic elements in the control loop. Characteristic of real process. Nonlinear control elements. Control system instrumentation. Feedback controller tuning. Continuous cycling method. Process reaction curve method. Feed-forward and ratio control design and tuning. Direct digital control (DDC). Minimal prototype algorithm. Internal model control. Degrees of freedom for process control. Process control design considerations. Industrial case study.

Course Objectives

The student should be able to:

- Apply modeling methods for different process and methods of tuning
- Model the process control (chemical, electromechanical, etc), Tuning of controller
- Design the process control

Course Topics

- Mathematical modeling of chemical processes
- Dynamic elements in the control loop
- Characteristic of real process
- Nonlinear control elements
- Control system instrumentation
- Feedback controller tuning
- Continuous cycling method
- Process reaction curve method
- Feed-forward and ratio control design and tuning
- Direct digital control (DDC)
- Minimal prototype algorithm
- Internal model control
- Degrees of freedom for process control
- Process control design considerations
- Industrial case study

References

- D.E. Seborg, T.F. Edgar and D.A. Mellichamp, "*Process Dynamics and Control*", John Wiley, 2004.
- P.S. Buckley, "*Techniques of Process Control*", Robert E. Kriegre Publishing Company, N.Y., 1979.

Course Code : **EE 719**

Course Title : **Intelligent Control Systems**

Credit Hours : **3**

Course Description

Knowledge representation techniques. Function of an expert system. Main structure of an expert system. Rule base. Inference engine. Reasoning module. Artificial intelligence and expert system application studies.

Course Objectives

The student should be able to:

- Construct the intelligent and expert system
- Get knowledge of expert system
- Apply the expert and artificial intelligent in control system

Course Topics

- Knowledge representation techniques
- Function of an expert system
- Main structure of an expert system
- Rule base
- Inference engine
- Reasoning module
- Artificial intelligence and expert system application studies
- Soft computing

References

- P. Jackson, "*Introduction to Expert Systems*", Addison Wesley, 1990.
- Dean, "*Artificial Intelligence (Theory and Practice)*", The Benjamin/ Cummings Publishing Company, 1995.
- J. S Albus and A. M. Meysrel, " *Intelligent Systems: Design and Control*", 2001
- Zi-Xing Cai, "*Intelligent Control: Principles, Techniques and Applications*", 1998

Course Code : **EE 721**

Course Title : **Dynamics of Electrical Machines**

Credit Hours : **3**

Course Description

Conventional analysis of machine dynamics. Generalized equation of machines. Active and passive transformation. Transient performance of various machines including three-phase and unbalanced short circuits. Dynamics of regulated machines. The effects of voltage regulator and governor on synchronous generators. Stability analysis using various stability criteria.

Course Objectives

The student should be able to:

- Represent the electric machines in their non linear models.
- Analysis and monitor the machine performance in both transient and steady state modes.
- Construct a complete model for the whole system and study the effect of disturbances.

Course Topics

- Conventional analysis of machine dynamics
- Generalized equation of machines
- Active and passive transformation
- Transient performance of various machines including three-phase and unbalanced short circuits
- Dynamics of regulated machines
- The effects of voltage regulator and governor on synchronous generators
- Stability analysis using various stability criteria

References

- C. Ong, "*Dynamic Simulation of Electric Machinery Using Matlab/Simulink*", Prentice-Hall, N.J., 1998.
- J. J. Cathey, "*Electric Machines Analysis and Design Applying MATLAB*", McGraw-Hill, London, 2001.

Course Code : **EE 722**

Course Title : **Computer Aided-Analysis of Electrical Machines**

Credit Hours : **3**

Course Description

Application of Maxwell's Equation in electric machines analysis in d-q representation of special quantities. An electric machine as a circuit element. The role of magnetic energy in electromechanical energy conversion. Steady-state performance of induction machines. Steady-state performance of commutator machines. Steady-state performance of synchronous machines. Electric machine dynamics. Description and utilization of mathematical software of electric machines analysis and design.

Course Objectives

The student should be able to:

- Represent any rotating electric machines in d-q model.
- Extract the output power; either electrical or mechanical from the model.
- Use the latest software packages to represent the models such as MATLAB or ANSOFT.

Course Topics

- Application of Maxwell's equation in electric machines analysis in d-q representation of special quantities
- An electric machine as a circuit element
- The role of magnetic energy in electromechanical energy conversion
- Steady-state performance of induction machines
- Steady-state performance of commutator machines
- Steady-state performance of synchronous machines
- Electric machine dynamics
- Description and utilization of mathematical software of electric machines analysis and design

References

- V. Ostovic, "*Computer-Aided Analysis of Electric Machines*", Prentice-Hall, 1994.
- A. K. Mukhopadhyay, "*Matrix Analysis of Electrical Machines*", New Age International, New Delhi, 1996.

Course Code : **EE 723**

Course Title : **Advanced Analysis and Design of Electric Motors**

Credit Hours : **3**

Course Description

Induction motor analysis and design. Synchronous motor analysis and design. Direct-current analysis and design. Testing for performance. Motor insulating systems. Motor control and motor protection. Energy-efficient motors. Economics of energy-efficient motors and systems. Environmental considerations. Reliability.

Course Objectives

The student should be able to:

- Select and design the appropriate motor for the chosen load.
- Design each element in the motor including protection components
- Study the economic aspects in conjunction with performance optimization.

Course Topics

- Induction motor analysis and design
- Synchronous motor analysis and design
- Direct-current analysis and design
- Testing for performance
- Motor insulating systems
- Motor control and motor protection
- Energy-efficient motors
- Economics of energy-efficient motors and systems
- Environmental considerations
- Reliability

References

- R. H. Engelmann and W. H. Middendorf, "*Handbook of Electric Motors*", M.Dekker Inc. N.Y., 1995.
- J. C. Andreas, "*Energy-Efficient Electric Motors*", M. Dekker Inc. N.Y., 1994.
- J. Hindmarsh, "*Electrical Machines and their Applications*", Pergamon Press, 1970.

Course Code : **EE 724**

Course Title : **Electrical Drives 3**

Credit Hours : **3**

Course Description

Review of Power semiconductor devices and circuits. Matching between motor and load characteristics, DC or AC drives?, AC and DC machines for drives. Voltage and Current fed converters driving DC and AC motors. Control techniques in Advanced drive systems.

Course Objectives

The student should be able to:

- Choose the power electronic device suitable for the nature of the selected power supply and drive.
- Understand the different techniques for driving DC and AC machines.
- Simulate and analyze different electric drive systems.
- Study the new trends in electric machine drives.

Course Topics

- Review of power semiconductor devices and circuits
- Matching between motor and load characteristics,
- DC or AC drives?
- AC and DC machines for drives
- Voltage and current fed converters driving DC and AC motors
- Control techniques in advanced drive systems

References

- B. Gray, "*Electrical Machines and Drive Systems*", Longman, 1990.
- B. K. Bose, "*Modern Power Electronics and AC Drives*", Prentice Hall, 2002.

Course Code : **EE 725**

Course Title : **Power Electronics 3**

Credit Hours : **3**

Course Description

Review for recent power electronic devices, Practical considerations for gate drive signals, New trends in converter topology, Applications of power electronics: Electric machine drives, utilities and power systems.

Course Objectives

The student should be able to:

- Study the new trends in Power electronic devices and circuits.
- Simulate and analyze different types of power electronic converters.
- Understand recent applications of power electronics.

Course Topics

- Review for recent power electronic devices
- Practical considerations for gate drive signals
- New trends in converter topology
- Applications of power electronics
- Electric machine drives
- Utilities and power systems

References

- M. H. Rashid, "*Power Electronics Circuits, Devices and Applications*," Prentice Hall, 2004.
- N. Mohan, T. Undeland and W. Robbins, "*Power Electronic Converters: Applications and Design*", Wiley, 2003.
- F.L. Luo, H. Ye and M. Rashid, "*Digital Power Electronics and Applications*", Elsevier, 2005.

Course Code : **EE 726**

Course Title : **Vector Control of Electrical Drives**

Credit Hours : **3**

Course Description

AC Motor models for drive application. Fundamentals of induction motors. Vector control of voltage source inverter fed induction motor and synchronous motor drives. Vector control of current source inverter fed induction motor and synchronous motor drives. Vector control of cyclo-converter-fed synchronous motor drives.

Course Objectives

The student should be able to:

- Learn to represent the electric machines in their complex vector models.
- Analysis and extract the machine parameters in both transient and steady state modes.
- Compare vector control performance with any other technique such as constant V/F control.

Course Topics

- AC Motor models for drive application
- Fundamentals of induction motors
- Vector control of voltage source inverter fed induction motor and synchronous motor drives
- Vector control of current source inverter fed induction motor and synchronous motor drives
- Vector control of cyclo-converter-fed synchronous motor drives

References

- Boldea and S. A. Nasar, "*Vector control of AC Drives*", CRC Press, 1992.
- S. Yamamura, "*Spiral Vector Theory of AC Circuit and Machines*", Clarendon Press, Oxford, 1992.
- P. Vas, "*Electrical Machines and Drives: A Space Vector Theory Approach*", Clarendon Press, Oxford, 1992.

Course Code : **EE 727**

Course Title : **Advanced Electrical Machines**

Credit Hours : **3**

Course Description

Permanent magnet technology. Brushless DC motors and PM machines. Theory and performance of: Variable reluctance stepper motors, Permanent magnet stepper motors, Hybrid stepper motor. Casting construction. Drive circuit. Operation modes. Application. Solid rotor machines theory and their application. Homo-polar and hetero-polar machines

Course Objectives

The student should be able to:

- Study magnetic characteristics of permanent and excited magnets.
- Represent the saliency effect of singly excited machines.
- Simulate special machines in friendly user soft ware packages.

Course Topics

- Permanent magnet technology
- Brushless DC motors and PM machines
- Theory and performance of:
    - Variable reluctance stepper motors
    - Permanent magnet stepper motors
    - Hybrid stepper motor
- Casting construction
- Drive circuit
- Operation modes and Applications
- Solid rotor machines theory and their application
- Homo-polar and hetero-polar machines

References

- T. Kenjo, A. Sugwara, "*Stepping Motors and their Microprocessors Controls*", Clarendon Press, Oxford, 1994.
- J. F. Gieras and M. Wing, "*Permanent Magnet Motor Technology: Design and Applications*", Marcel Dekker, N.Y., 1997.

Course Code : **EE 728**

Course Title : **Industrial Power Conversion Systems**

Credit Hours : **3**

Course Description

Open loop control of DC drives. Series connected converters. Reversible drives. Dynamic braking. Closed loop control of DC drives. Regenerative braking. Phase locked loop control. Micro computer control. Open loop control of AC drives: induction, synchronous and permanent magnet motors. Closed loop control of AC drives. Current source and voltage source inverter-fed motor systems.

Course Objectives

The student should be able to:

- Simulate power electronic drive circuit in conjunction with the selected motor.
- Analyze the drive performance to be ready for controlling.
- Build the appropriate interfacing between the drive and the digital controller such as PLC or Microprocessor.

Course Topics

- Open loop control of DC drives
- Series connected converters
- Reversible drives
- Dynamic braking
- Closed loop control of DC drives
- Regenerative braking
- Phase locked loop control
- Micro computer control.
- Open loop control of AC drives:
    - Induction motor
    - Synchronous and permanent magnet motors
- Closed loop control of AC drives
- Current source and voltage source inverter-fed motor systems

References

- C. B. Gray, "*Electrical Machines and Drive Systems*", Longman, 1990.
- V. Subrahmanyam, "*Thyristor Control of Electric Drives*", Tata McGraw Hill, New Delhi, 1988.
- G. C. Barney and AG Laher, "*Elevator Electric Drives: Concepts and Principles, Control and Practice*", Ellis Harwood Ltd., New York, 1990.

Course Code : EE 729

Course Title : Generalized Theory of Electrical Machines

Credit Hours : 3

Course Description

Application of matrix algebra to static electrical networks. The matrix equation of the basic rotating machine. The torque expressions. Linear transformation in circuits and machines. Steady state performance in DC, single-phase commutator machines and poly phase machines. Steady state performance. Transient in AC machined. Reference frames and applications.

Course Objectives

The student should be able to:

- Analysis any global rotating machine into perpendicular d and q axes.
- Extract the machine output in both transient and steady state modes.
- Build a complete model for the machine either in soft ware package or in ready made block diagram packages such as SIMULINK inside MATLAB.

Course Topics

- Application of matrix algebra to static electrical networks
- The matrix equation of the basic rotating machine
- The torque expressions
- Linear transformation in circuits and machines
- Steady state performance in DC, single-phase commutator machines and poly phase machines
- Steady state performance
- Transient in AC machined
- Reference frames and applications

References

- A. K. Mukhopadhyay, "*Matrix Analysis of Electrical Machines*", New Age International, New Delhi, 1996.
- Boldea and S. A. Nasar, "*Vector control of AC Drives*", CRC Press, 1992.

Course Code : **EE 740**

Course Title : **Transients in Power Systems**

Credit Hours : **3**

Course Description

Nature and characteristics of switching and lightning over voltages. Abnormal transient phenomena: Re-strike, arcing faults, Current chopping, Ferro-resonance, etc. lightening phenomena in the atmosphere. Methods of computation of transients: frequency domain and time domain analysis techniques. Basis of EMTP and its application. Shielding. Surge protection devices. Insulation coordination. Transient measuring techniques.

Course Objectives

The student should be able to:

- Know transient phenomena in power system.
- Understand the sources of transients in power systems.
- Design the methods for computing and analyzing transients.
- Understand Surge Protection devices and Insulation Coordination.

Course Topics

- Nature and characteristics of switching and lightning over voltages
- Abnormal transient phenomena:
    - Re-strike, arcing faults
    - Current chopping, Ferro-resonance,
    - Lightening phenomena in the atmosphere
- Methods of computation of transients:
    - frequency domain
    - time domain analysis techniques
- Basis of EMTP and its application
- Shielding
- Surge protection devices
- Insulation coordination.
- Transient measuring techniques.

References

- A. Greenwood, "*Electrical Transients in Power Systems*", Wiley, N.Y., 1991.
- P. Chowdhuri, "*Electromagnetic Transients in Power Systems*", Research studies publisher, Taunton, 1996.

Course Code : **EE 741**

Course Title : **HVDC Power Transmission**

Credit Hours : **3**

Course Description

Problems of long distance power transmission. Advantages of HVDC. Combined AC, DC transmission systems. Terminal apparatus, converters, inverters, thyristor bridge circuits, thyristor valves. Performance requirements and control circuit features. Protection schemes. Digital simulation techniques. Switching and fault-clearance over voltages. RIV and corona in DC transmission lines.

Course Objectives

The student should be able to:

- Thoroughly understand the HVDC system transmission system and its components.
- Get the performance requirements of DC transmission line.
- Simulate the HVDC system.

Course Topics

- Problems of long distance power transmission
- Advantages of HVDC
- Combined AC, DC transmission systems
- Terminal apparatus, converters, inverters, thyristor bridge circuits, thyristor valves
- Performance requirements and control circuit features
- Protection schemes
- Digital simulation techniques
- Switching and fault-clearance over voltages
- RIV and corona in DC transmission lines

References

- E. W. Kimbark, "*Direct Current Transmission, Vol. I and II*", J. Wiley, 1971.
- J. Arrilage, "*High Voltage Direct Current Transmission*", IEE, London, 1998.

Course Code : **EE 742**

Course Title : **Electrical Insulation Engineering**

Credit Hours : **3**

Course Description

Vacuum, gases, liquids and solids as electrical insulating media. Concept of electrical breakdown. Breakdown in gases, liquids and solids. Uniform and non-uniform fields. Insulation systems in bushings, transformers, cables, capacitors and circuit breakers. Partial discharges. Phenomenological theory of ageing: ageing mechanisms under electrical, thermal and combined stresses. Techniques for electrical non-destructive evaluation of materials. High voltage test techniques.

Course Objectives

The student should be able to:

- Know the types of insulating materials and the phenomenon of electric breakdown insulation materials.
- Illustrate the systems for different components of electric power systems.
- Test the electric equipment.

Course Topics

- Vacuum, gases, liquids and solids as electrical insulating media
- Concept of electrical breakdown
- Breakdown in gases, liquids and solids
- Uniform and non-uniform fields
- Insulation systems in bushings, transformers, cables, capacitors and circuit breakers
- Partial discharges
- Phenomenological theory of ageing: ageing mechanisms under electrical, thermal and combined stresses
- Techniques for electrical non-destructive evaluation of materials
- High voltage test techniques

References

- M. Khalifa, "*High Voltage Engineering*", M. Dekker, N.Y. 1990.
- Bradewell, "*Electrical Insulation*", Peter Peregrinus, London, 1983.
- M. Abdel-Salam, H. Anis ,A. El-Morshedy and R. Radwan, "*High Voltage Engineering - Theory and Practice*", Marcel Dekker Inc. , NY, 2nd Edition, 2000

Course Code : **EE 743**

Course Title : **Power System Reliability**

Credit Hours : **3**

Course Description

Review of basic probability theories. Basic reliability concepts and definitions. Static generation capacity reliability. Spinning generation capacity reliability. Composite system reliability. Overall reliability and Economic planning.

Course Objectives

The student should be able to:

- Understand power system reliability definitions.
- Apply reliability calculations of power generation.
- Apply system reliability calculations for transmission networks.
- Plane the overall power system reliability.

Course Topics

- Review of basic probability theories
- Basic reliability concepts and definitions
- Static generation capacity reliability
- Spinning generation capacity reliability
- Composite system reliability
- Overall reliability
- Economic planning

References

- R. Billington and R. N. Allan, "*Reliability Evaluation of Power Systems*", Pitman Publishers, 1984.
- E. E. Lewis, "*Introduction to Reliability Engineering*", Wiley, 1996.

Course Code : **EE 744**

Course Title : **Reactive Control in Electrical Power Systems**

Credit Hours : **3**

Course Description

Introduction to VAR control theory of load compensation. Practical considerations. VAR control in transmission networks under steady state. Series and shunt compensators. Dynamic shunt compensation. Static compensation: types and characteristics. Static VAR compensators in AC and HVDC systems. Typical applications of dynamic compensation and distribution systems. Harmonics. Reactive power management.

Course Objectives

The student should be able to:

- Apply the VAR control theory of load compensation and its practical considerations. Get acquainted with the different types of load compensators and know its characteristics and modeling.
- Design the thyristor controllers and its application in both transmission and distribution systems.

Course Topics

- Introduction to VAR control theory of load compensation
- Practical considerations
- VAR control in transmission networks under steady state
- Series and shunt compensators
- Dynamic shunt compensation
- Static compensation: types and characteristics
- Static VAR compensators in AC and HVDC systems
- Typical applications of dynamic compensation and distribution systems
- Harmonics
- Reactive power management

References

- T. J. Miller, "*Reactive Power Control in Electric Power Systems*", J. Wiley, N.Y., 1982.
- P. Kundur, "*Power System Stability and Control*", McGraw Hill Inc., 1994.
- C. Taylor, "*Power System Voltage Stability*", EPRI series, 1994.

Course Code : **EE 745**

Course Title : **Power System Control and Stability**

Credit Hours : **3**

Course Description

Machine voltage control: Exciters. System voltage control. Modeling of interconnected systems. System dynamics. Stability concepts. Steady state and Transient stability. Multi-machine systems. Dynamic stability. Power system stabilizers. Static VAR systems. DC links. Phenomenon of synchronous resonance.

Course Objectives

The student should be able to:

- Understand the excitation systems and their modeling.
- Understand the main concepts of stability – steady state – transient – dynamic.
- Understand the operation of VAR systems.
- Understand the DC links.

Course Topics

- Machine voltage control
- Exciters
- System voltage control
- Modeling of interconnected systems
- System dynamics
- Stability concepts
- Steady state
- Transient stability
- Multi-machine systems
- Dynamic stability
- Power system stabilizers
- Static VAR systems
- DC links
- Phenomenon of synchronous resonance

References

- O. L. Elgerd, "*Electric Energy System and Theory*", McGraw-Hill, N.Y. 1982.
- P. M. Anderson and A. A. Fouad, "*Power System Control and Stability*", IEEE Computer Society Publisher, 1994.

Course Code : EE 746

Course Title : Computer Control of Power Systems

Credit Hours : 3

Course Description

State transition diagram. Security oriented functions. Data acquisition (SCADA systems). State estimation. Load forecasting. Economic load dispatch. Reactive power control. Contingency evaluation. Real time control and protection.

Course Objectives

The student should be able to:
- Understand data acquisition, transmission and processing (SCADA systems).
- Understand reactive power control and protection.

Course Topics

- State transition diagram
- Security oriented functions
- Data acquisition (SCADA) systems
- State estimation
- Load forecasting
- Economic load dispatch
- Reactive power control
- Contingency evaluation
- Real time control and protection

References

- P. M. Anderson and A. A. Fouad, "*Power System Control and Stability*", IEEE Computer Society Publisher, 1994.
- T. J. Miller, "*Reactive Power Control in Electric Systems*", J. Willey, N. Y. 1982.

Course Code : **EE 747**

Course Title : **Solid State Relays and Its Applications**

Credit Hours : **3**

Course Description

General review of static relays. Comparators and associated elements. Type of relays. Multi-input comparators circuit and associated relays. Non-conventional types of comparators. Computer applications to protective relaying. Microprocessor applications to protection. Reliability, testing and maintenance.

Course Objectives

The student should be able to:

- Know new techniques in relay industries.
- Understand the types of static relays and its components.
- Apply the different types of digital relays.

Course Topics

- General review of static relays
- Comparators and associated elements
- Type of relays
- Multi-input comparators circuit and associated relays
- Non-conventional types of comparators
- Computer applications to protective relaying
- Microprocessor applications to protection
- Reliability, testing and maintenance

References

- T.S.M. Rao, "*Power System Protection: Static Relays with microprocessor Applications*", Tata McGraw-Hill, New Delhi, 1989.
- P. M. Anderson, "Power System Protection", IEEE Computer Society Pr., N.Y., 1999.
- E.W. Kimbark, "*Power System Stability*, Vol. IV, Power Circuit Breakers and Protective Relays", IEEE Press, 1995.
- A.T. Jones and S.K. Salama, "*Digital Protection for Power Systems*", IEE, London, 1994.

Course Code : **EE 748**

Course Title : **Power System Analysis**

Credit Hours : **3**

Course Description

System modeling and load flow analysis. Optimum operation and control. Data acquisition, transmission and processing (SCADA system). Frequency, voltage and VAR control. Optimum control. Introduction to power system reliability. Unbalanced system analysis. Transient stability analysis. Harmonics; measuring, elimination with passive and active filters.

Course Objectives

The student should be able to:

- Build confidence and understanding of those concepts of power system analysis that are likely to be encountered in the study and practice of electric power engineering.
- Develop network models based on the admittance and impedance representations.
- Studying applications commonly encountered in electric power system engineers practice.

Course Topics

- System modeling and load flow analysis
- Optimum operation and control
- Data acquisition, transmission and processing (SCADA system)
- Frequency, voltage and VAR control
- Optimum control
- Introduction to power system reliability
- Unbalanced system analysis
- Transient stability analysis
- Harmonics measuring
- Harmonics elimination with passive and active filters

References

- O.L. Elgerd, "*Electric Energy System Theory*", McGraw-Hill, N.Y., 1982.
- P.M. Anderson and A.A. Fouad, "*Power System Control and Stability*", IEEE Computer Society Publisher, 1994.
- L. L. Grisby, "*Power System Stability and Control*", CRC PR., 2007.

Course Code : **EE 749**

Course Title : **Renewable Energy Systems**

Credit Hours : **3**

Course Description

Introduction to Renewable Energy Sources: Geothermal energy, Bio-Energy, Tidal sources of energy, Ocean energy, Solar energy, Wind Energy. – Solar Energy: Characteristics of solar radiation, Solar thermal energy (active solar heating, solar thermal energies, passive solar heating), Solar Photovoltaic: Basic considerations, Electrical Characteristics, PV system components and types, PV system sizing and applications, Present and future status of solar systems. – Wind Energy: Wind speed and Energy distribution (Speed / Power relation, Power extracted from the wind), System components, Electricity generation systems, Present and future status of wind systems. – Economics of Energy systems. – Environmental aspects of energy systems.

Course Objectives

The student should be acquainted with:

- The various renewable energy systems.
- Decision making based on energy systems economics and environmental aspects.

Course Topics

- Introduction to Renewable Energy Sources: Geothermal energy, Bio-Energy, Tidal sources of energy, Ocean energy, Solar energy, Wind Energy
- Solar Energy:
    - Characteristics of solar radiation
    - solar thermal energy active solar heating
    - solar thermal energies passive solar heating
- Solar Photovoltaic: Basic considerations, Electrical Characteristics, PV system components and types, PV system sizing and applications, Present and future status of solar systems
- Wind Energy: Wind speed and Energy distribution (Speed / Power relation, Power extracted from the wind), System components, Electricity generation systems, Present and future status of wind systems
- Economics of Energy systems
- Environmental aspects of energy systems

References

- Bent Sørensem, “*Renewable Energy*”, ELSEVIER Academic press, 2004.
- Godfrey Boyle, “*Renewable Energy*”, Open University, Oxford, 2004.
- John Twidell, “*Renewable Energy Resources*”, Spon press, London, 2004.

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