M.Sc./P.G. Diploma Course in Electrical Engineering

Curriculum and Scheme of Evaluation

Code	Course Modules	Credits[1]	Evaluation[2] (%)	
			Assignments	Final Exam
Compulsory Modules				
EE 5034	Power System Reliability	2.5	40±20	60±20
EE 5052	Energy Economics	2.5	40±20	60±20
EE 5093	Power System Planning and Operation	2.5	40±20	60±20
EE 5094	Power System Protection and Stability	2.5	40±20	60±20
EE 5095	Advanced Power Electronics	2.5	40±20	60±20
EE 5117	Electromagnetic Compatibility and Power Quality	2.5	40±20	60±20
EE 5092	Research Methodology and Minor Projects	2.5	100 [3]	-
EE 6099	Dissertation (for MSc)	20	-	100
Optional Modules				
EE 5053	Energy Efficiency, Demand Management and Conservation	2.5	40±20	60±20
EE 5057	Energy and Environment	2.5	40±20	60±20
EE 5086	Project Management	2.5	40±20	60±20
EE 5087	Human Resource Management	2.5	40±20	60±20
EE 5096	Advanced Engineering Mathematics	2.5	40±20	60±20
EE 5091	Small Hydro Project Development	2.5	40±20	60±20
EE 5097	Variable Speed Drives and Large Electrical Machines	2.5	40±20	60±20
EE 5102	Power Distribution Systems	2.5	40±20	60±20
EE 5103	Nuclear Power Engineering	2.5	40±20	60±20
EE 5104	Smart Technologies in Power Systems	2.5	40±20	60±20
EE 5118	Building Management Systems	2.5	40±20	60±20
EE 5123	Lightning Protection and Earthing	2.5	40±20	60±20
EE 5124	Procurement and Inventory control	2.5	40±20	60±20
EE 5127	Computer Aided Design (CAD) Tools	2.5	100	-
EE 5011	DC Motor Drives	2.5	40±20	60±20
EE 5021	Power Switching Devices	2.5	40±20	60±20

Recommended by Senate Curriculum and Evaluation Committee meeting held on 20th December 2017

Code	Course Modules	Credits[1]	Evaluation[2] (%)	
			Assignments	Final Exam
EE 5022	Power Supplies and Applications	2.5	40±20	60±20
EE 5023	Resonant Converters	2.5	40±20	60±20
EE 5028	Power Electronic Converter Harmonics	2.5	40±20	60±20
EE 5054	Energy Planning	2.5	40±20	60±20
EE 5056	New, Renewable and Rural Energy Systems	2.5	40±20	60±20
EE 5062	Digital Control	2.5	40±20	60±20
EE 5075	Artificial Intelligence Applications	2.5	40±20	60±20
EE 5081	Operations Research	2.5	40±20	60±20
EE 5082	Numerical Methods	2.5	40±20	60±20
EE5205	Control Systems Design	2.5	40±20	60±20
EE 5209	Mechatronics	2.5	40±20	60±20
EE 5210	Sensors and Actuators for Automation	2.5	40±20	60±20
EE 5216	Real-time Systems	2.5	40±20	60±20
EE 5217	System Automation Technologies	2.5	40±20	60±20
EE5105	Applied Power Quality Modelling and Analysis	2.5	40±20	60±20
EE 5121	Air Conditioning, Ventilation and Fire Safety	2.5	40±20	60±20
EE 5212	Systems Control and Automation	2.5	40±20	60±20
EE5106	Advanced Power System Protection	2.5	40±20	60±20

[1] 1 credit corresponds to 14 hours of lectures or equivalent

[2] The mean value in the evaluation scheme is the default value. It can be changed by the Lecturer/Examiner concerned, within the specified range, by announcement to the students at the commencement of the course unit.

[3] Evaluation is based on the requirements as specified in clause 4.1(c) of the By-Law.

Syllabi of Course Units

1. EE 5034 Power System Reliability

Learning Outcomes: On completion of this module, students should be able to 1. quantify reliability of Electrical power systems and to make recommendations to improve reliability of such systems.
Outline Syllabus: 1. Frequency balance approach for system reliability analysis; 2. Power system reliability analysis; 3. Discrete convolution method; 4. Basic concept of continuous distribution approximation; 5. Multi-area reliability analysis; decomposition approach; 6. One area reliability connected to assisting area; 7. Simultaneous decomposition-simulation; 8. Monte-Carlo simulation; 9. Composite system reliability evaluation

2. EE 5052 Energy Economics

Learning Outcomes: On completion of this module, students should be able to 1. identify the sensitivity of national economies to energy
Outline Syllabus: 1. Energy as a sector of a national economy; 2. Demand analysis; 3. Price and income elasticity of demand; self- and cross-price elasticities; 4. Identification of determinants of demand; 5. Energy demand forecasting using trend, time-series, econometric; end-use and hybrid techniques; judgmental methods; 6. Costing of Externalities of energy 7. Typical issues in developed and developing countries. Economic comparison of supply-side energy options; 8. Economic and financial cost-benefit analysis of energy projects; 9. Analysis of demand-side options and substitution options.

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3. EE 5093 Power System Planning and Operation

Learning Outcomes:

On completion of this module, students should be able to

1. to identify techniques used in planning an electric power system under competitive market conditions.
2. to evaluate the economic operation of power generation and transmission networks.

Outline Syllabus:

1. Planning in a competitive electricity industry: forward markets and the concept of coordinated pricing and planning.
2. Sustainability and the role of distributors;
3. Review of practical approaches adopted internationally and in Sri Lanka.
4. Relationship to overall energy planning: Dimensions of system planning; objectives, categories of analysis, complexities, utility development philosophies
5. Issues in planning generating systems; demand, technology options, economic evaluation, reliability, constraints
6. Generation system costs; levelized costs of generation, Production Cost Analysis
7. Models for long-range electric system analysis.
8. Unit commitment; thermal and hydro constraints, fuel constraints, spinning reserve, Solution methods, priority list methods, dynamic programming:
9. Economic dispatch; Transmission losses, Lambda -iteration method, First and Second Order Gradient method, Base Point and Participation Factors

4. EE 5094 Power System Protection and Stability

Learning Outcomes:

On completion of this module, students should be able to

1. familiar with various criteria used in protecting power system components.
2. use modern techniques in power system protection schemes.
3. distinguish between different stability problems and to apply modern techniques to study the stability of power generating and transmission systems.

Outline Syllabus:

1. Elements of system protection, types of protective relays, monitoring system conditions, fault characteristics,
2. Different Protection schemes
3. testing and commissioning of protective schemes
4. Fault calculations and relay settings,
5. Relay testing techniques
6. Fundamental concepts and physical aspects of small-signal stability, Transient stability, Sub-synchronous oscillations & voltage stability,
7. Techniques available for stability analysis of small and large electric power systems,
8. Methods for improving stability of practical power systems, their limitations and methods to overcome them,
9. Case studies using EMTDC/PSCAD

5. EE 5095 Advanced Power Electronics

Learning Outcomes:

On completion of this module, students should be able to

1. demonstrate the knowledge of advanced power converter systems and carry out reliable designs

Outline Syllabus:

1. Technology overview
2. Device level designs of converters
3. Multilevel converters
4. Bulk power converters in power systems
5. Design of power supplies

6. EE 5117 Electromagnetic Compatibility and Power Quality

Learning Outcomes:

On completion of this module, students should be able to

1. to estimate and mitigate the effects of electromagnetic interference in electrical installations.
2. to be able to quantify and mitigate power quality issues in electrical installations.

Outline Syllabus:

1. Sources of electromagnetic interference (EMI)
2. EMI types
3. EMI prediction
4. EMI measurement EMI reduction techniques
5. Modelling of EMI
6. Standards and specifications related to EMI
7. Electromagnetic compatibility simulation
8. Classification of power quality disturbances and introduction to their origin and effects.
9. Long term voltage variations
10. Voltage unbalance and unbalance factor
11. Voltage sags, CBEMA curve (ITIC)
12. Voltage fluctuations and lamp flicker
13. Transients due to capacitor switching
14. Harmonics and their effects
15. Harmonic standards
16. Power quality monitoring.

7. EE 5092 Research Methodology and Minor Projects

Learning Outcomes:

On completion of this module, students should be able to

1. Formulate research proposals and write technical papers/dissertations
2. apply data analysis techniques for research work
3. undertake independent research
4. summarize and present results

Outline Syllabus:

1. Introduction to concepts of scientific research
2. Research proposal writing
3. Critical review techniques
4. Preparation of technical reports/research papers/ dissertation
5. Methods for data analysis
6. Interpretation and presentation of data
7. Strategies for summarising and presenting technical papers

8. Preparation of Project Report

8. EE 6099 Dissertation

Learning Outcomes:

To enable students to

1. apply skills gained in the course to a multidisciplinary project incorporating realistic constraints and engineering standards.
2. effectively express technical ideas through written and oral communication.
3. apply specific skills in defining, planning, and scheduling projects,

Outline Syllabus:

The student is expected to work individually on a research dissertation on a topic assigned or agreed by the Department. It is to be carried out for a period of not less than one academic year, on a part time basis (or equivalent period full time) under the supervision of a senior staff member and/or industrial supervisors. The student is expected to develop a complete plan from feasibility study, cost analysis, through electrical design and documentation to the building of a prototype or developing of a model as applicable. All students must make a formal written and verbal presentation to a panel.

9. EE 5053 Energy Efficiency, Demand Management and Conservation

Learning Outcomes:

On completion of this module, students should be able to

1. Understand the important issues related to energy policy.
2. identify and quantify the typical energy management opportunities to perform energy assessments of industrial and commercial buildings, including determining data needs, utilizing instrumentation, and analysing and presenting results.

Outline Syllabus:

1. Supply-side efficiency issues
2. power system loss optimization
3. Efficiency issues in oil exploration and refining
4. Demand-side efficiency issues;
5. efficiency/efficacy of typical endues devices such as motors, lighting devices, air conditioning systems, transportation, boilers, furnaces, conventional and improved stoves;
6. scope for improvement;
7. recent development worldwide and in Sri Lanka. Energy auditing;
8. energy systems in typical industrial and commercial buildings;
9. how to conduct an energy audit;
10. measurements and instrumentation;
11. worked example of a preliminary energy audit in an industry;
12. project identification and financial evaluation

10. EE 5057 Energy and Environment

Learning Outcomes:

On completion of this module, students should be able to

1. provide state-of-the-art education in the fields of energy utilization by means of economically and environmentally sustainable systems and technologies.

Outline Syllabus:

1. Environmental impacts of energy systems;
2. Supply-side and demand-side impacts;
3. Mitigatory measures;
4. Environmental economics;
5. Analysis of environmental attributes an decision-making;
6. Environmental regulations in Sri Lanka,
7. Standards for contaminants and other guidelines.

11. EE 5086 Project Management

Learning Outcomes:

On completion of this module, students should be able to

1. Distinguish project management from day to day management of business.
2. Demonstrate sufficient knowledge in various disciplines of project management.
3. Acquire necessary skills and ability to use modern day tools for project management.

Outline Syllabus:

1. Project management concepts.
2. Characteristics of a project.
3. Project cost estimation.
4. Feasibility report.
5. Project financing.
6. Project appraisal.
7. Project control.
8. Risk mitigation and management.
9. Project scheduling.
10. Conflict resolution and negotiations.
11. Software tools for project management

12. EE 5087 Human Resource Management

Learning Outcomes:

On completion of this module, students should be able to

1. Formulate a human resource development strategy for an organization
2. Design and monitor KPI (key performance indicators) for HRM
3. Implement HRM practices in an organization

Outline Syllabus:

1. Human resource planning, Job analysis and Job design
2. Recruitment and selection
3. Training and development
4. Managing performance
5. Reward Management
6. Human Resource Information systems
7. Strategic Human resource management
8. Managing Labour relations,

13. EE 5096 Advanced Engineering Mathematics

Learning Outcomes On completion of this module, students should be able to 1. Analyse and model engineering situations and solve engineering problems using linear algebra, non-linear and partial differential equations, vector calculus, finite element analysis, linear and dynamic programming, statistical methods 2. Use software tools for analyse, model and solve engineering problems.
Outline Syllabus 1. Linear Algebra. 2. Non-linear and partial differential equations. 3. Finite Element Analysis. 4. Linear and dynamic programming. 5. Statistical methods. 6. Mathematical modelling of engineering problems using software tools.

14. EE 5091 Small Hydro Project Development

Learning Outcomes: On completion of this module, students should be able to 1. carry out techno-economic development of small hydro power schemes.
Outline Syllabus: 1. Preliminary studies, Hydrological studies and viability of the project, 2. Feasibility studies and design, Financial and sensitivity analyses, 3. Investor decisions and risk management, 4. Involvement of government organizations, Project implementation, 5. Facing contingency situations.

15. EE 5097 Variable Speed Drives and Large Electrical Machines

Learning Outcomes: On completion of this module, students should be able to 1. demonstrate the knowledge of Variable speed AC drives and transient behavior of large AC generators.
Outline Syllabus: 1. Recent developments 2. Variable speed AC motor drives 3. Transient analysis of large synchronous generators 4. Induction Generators in power systems

16. EE 5102 Power Distribution Systems

Learning Outcomes:

On completion of this module, students should be able to

1. demonstrate the knowledge of characteristics of power distribution systems
2. design and analyse protection schemes for power distribution systems
3. demonstrate the basic knowledge in planning and designing of power distribution systems

Outline Syllabus:

1. Introduction (Electrification, Importance of Distribution Systems, Urban and Rural Power Distribution Systems, Power Quality Fundamentals)
2. Load Characteristics and Consumer Classification
3. Distribution Systems and Its Features
4. Voltage Drop and Line Losses
5. Over-current Protection
6. Distribution System Planning

17. EE 5103 Nuclear Power Engineering

Learning Outcomes:

On completion of this module, students should be able to:

1. Identify modern nuclear power generation options, their limitations and safety issues, in the Sri Lankan context and to be able to identify the infrastructure requirements for a nuclear power program

Outline Syllabus:

1. Nuclear power in the Sri Lankan Context,
2. Basic Nuclear Physics,
3. Nuclear Power Plants
4. Nuclear Safety
5. Nuclear Power Projects,
6. Radiation Protection
7. Nuclear Reactor Analysis

18. EE 5104 Smart Technologies in Power Systems

Learning Outcomes:

On completion of this module, students should be able to:

1. demonstrate the knowledge on smart grids
2. demonstrate the knowledge on wide area protection
3. apply intelligence techniques to solve complex engineering problems in power system control

Outline Syllabus:

1. Distributed Generation and Microgrids, Introduction to Smart Grids
2. Wide Area Protection
3. Fuzzy logic, Multi agent systems, Genetic algorithm, neuro-fuzzy and combined intelligent techniques in power system control

19. EE 5118 Building Management Systems

Learning Outcomes

On completion of this module, students should be able to

1. Understand the management and control requirements of buildings for human comfort.
2. Use MIS system in Building management systems (BMS).
3. Design and implement a BMS.
4. Explain the structure of a Building Energy Management System (BEMS).

Outline Syllabus

1. Overview.
2. Human comfort in building designs.
3. Use of MIS in BMS.
4. Energy management systems.
5. Hardware and software for BMS.
6. Case studies.

20. EE 5123 Lightning Protection and Earthing

Learning Outcomes:

On completion of this module, students should be able to

1. apply lightning protection principles in the protection of electrical installations
2. design a grounding system for electrical installations considering safety issues and constraints placed.

Outline Syllabus:

1. Introduction to lightning. Lightning parameters.
2. Effects of lightning and protection principles.
3. Lightning protection of equipment, installations and high rise buildings.
4. Standards and specifications related to lightning protection.
5. Commonly used grounding arrangements and their resistance calculations.
6. Impulse impedance of grounding systems.
7. Step and touch potentials.
8. Measurement of Earth resistance and resistivity profile.
9. Principles of design of substation grounding, Project.
10. Earthing for lightning protection.

21. EE 5124 Procurement and Inventory control

Learning Outcomes

On completion of this module, students should be able to

1. Prepare bidding documents in keeping with technical specifications.
2. Prepare contract documents for technical projects.
3. Evaluate bids for award of contract.
4. Establish and maintain an inventory management system.

Outline Syllabus

1. Relationship between a "Project" and a "Contract".
2. Parties involved in the contract and their obligations, Duties of Engineer and Engineer's representative.
3. Contractor's responsibilities and appointment of sub contractors.
4. Types and selection of contracts, Standard forms of contract.
5. Preparation of Tender documents for invitation for bids.
6. Scope of work, Preamble, Specification & drawings, bills of quantities, payments and variations to the contract, claims, arbitration, engagement of labour, taxation.
7. Tender evaluation and selection, Contact awarding Procedures.
8. Inventory management.

22. EE 5127 Computer Aided Design (CAD) Tools

Learning Outcomes: On completion of this module, students should be able to 1. demonstrate the knowledge in using computer aided design tools for power system design and planning
Outline Syllabus: 1. CAD software for Transient studies 2. CAD software for Load Flow and Fault Analysis 3. CAD software for Contingency analysis 4. CAD software for Distribution planning

23. EE 5011 DC Motor Drives

Learning Outcomes: On completion of this module, students should be able to: 1. analyze and design of thyristor and chopper controlled dc motor drives. 2. gain knowledge on different modes of operation and closed loop control techniques.
Outline Syllabus: 1. DC motor types and characteristics, Constant torque and power modes, Starting and braking, 2. Half/full bridge single/three phase thyristor drives, 3. Supply side distortion, 4. Harmonic filters, 5. Multiconverters, Reversible converters, 6. Chopper controlled drives, 7. Closed loop control.

24. EE 5021 Power Switching Devices

Learning Outcomes:

On completion of this module, students should be able to:

1. gain deep understanding of different power switching devices
2. design power switching devices practical applications.

Outline Syllabus:

1. Features and limitations of power diodes, thyristors, GTOs, power BJTs, power MOSFETs, IGBTs and hybrid devices,
2. Methods of switching, Switching aid circuits,
3. Drive circuits, Driving bridge connected devices,
4. Design of protection circuits against over-voltages, over-currents, transient voltage spikes and shoot through faults,
5. Thermal design and heat sink selection,
6. Transient overloading.

25. EE 5022 Power Supplies and Applications

Learning Outcomes:

On completion of this module, students should be able to:

1. Design different types of dc and ac power supplies, UPS systems, switch mode power supplies

Outline Syllabus:

1. DC power supplies using fly-back, half/full bridge and push-pull methods,
2. Resonant and bi-directional power supplies,
3. Un-interruptible ac power supplies (UPS),
4. Switchmode, resonant and bi-directional ac power supplies,
5. Power factor conditioning,
6. Transformers for power supplies, Ferro-resonance.

26. EE 5023 Resonant Converters

Learning Outcomes:

On completion of this module, students should be able to

1. analyze and design various resonant converter topologies developed accomplish with zero voltage and zero current switching techniques obtained through resonance principle

Outline Syllabus:

1. Series, parallel and hybrid load resonant dc-dc converters, Resonant inverters,
2. Zero current switching (ZCS) converters,
3. Zero voltage switching (ZVS) converters,
4. Pseudo-resonant switching converters,
5. Resonant dc link inverters, High frequency dc link converters.

27. EE 5028 Power Electronic Converter Harmonics

Learning Outcomes:

On completion of this module, students should be able to:

1. understand harmonics produced by different converters,
2. gain knowledge on harmonic standards and various converter topologies developed for harmonic mitigation.

Outline Syllabus:

1. Harmonic requirements,
2. Harmonic reduction with double and autowound multipulse transformers,
3. Interphase and current control transformers,
4. Calculation of harmonics,
5. Meeting harmonic standards,
6. Practical applications.

28. EE 5054 Energy Planning

Learning Outcomes: On completion of this module, students should be able to 1. develop an integrated approach for national energy planning.
Outline Syllabus: 1. Development of an energy database; the national energy balance; development of a reference energy system. 2. Integrated National Energy Planning; 3. Energy sector policy analysis; strategic options; optimal energy mix; 4. Integrated Resource Planning; 5. Energy planning models for power generating systems, transmission and distribution, planning models in the petroleum sector; 6. Case study and worked examples.

29. EE 5056 New, Renewable and Rural Energy Systems

Learning Outcomes: On completion of this module, students should be able to carry out techno-economic analysis of renewable energy system development.
Outline Syllabus: 1. Emerging technologies (wind, solar, wave, tidal, OTEC); their status of development and economics; 2. design of a stand-alone renewable energy system; 3. design of a hybrid system. 4. Design and operation of grid-integrated renewable energy systems.

30. EE 5062 Digital Control

Learning Outcomes:

On completion of this module, students should be able to

1. Differentiate analog and digital control in terms of applications, theoretical, and implementation view points
2. Transform and apply analog control theories in the digital domain
3. Analyse and design digital control systems
4. Select best choice of microcontroller/DSP solutions to a given control system and implement

Outline Syllabus:

1. *Background*: Analog Vs Digital Control; Theoretical and implementation point of view comparison
2. *Mathematical Methods of Discrete Systems*: A Sampled Signal, Sampling and Data Hold, The z-transform, Properties of the z-transform, Inverse z-transform, Obtaining the *z*-transform when the Function in *s* is known
3. *Discrete time transfer function*: Stability and Pole Locations, Modified Routh's Criterion
4. *Design of Digital Control Systems*: Root Locus Method, Bode Plots, Digital PID Control, State Variable Methods, Controllability and Observability, State-feedback Control, MATLAB as a CAD tool
5. *DSPs in Control Systems*: Components of DSPs and hardware architectures, Selection of the Sampling Rate, Range and Round-off Error, Fixed-point Versus Floating-point Processors, Single-chip DSPs, Programming, Device Evaluation, and Debugging, DSP-based Chip Sets and Control Boards, Digital Implementation of Control Systems (PID Controllers, *n*th Order Digital Controllers, Motor Control, Robot Control, Active Power Factor Correction)

31. EE 5075 Artificial Intelligence Applications

Learning Outcomes

On completion of this module, students should be able to

1. understand artificial intelligence (AI) techniques and apply AI techniques in complex real world problems.

Outline Syllabus

1. Natural and Artificial Intelligence, Applications of AI in system automation, future directions of AI.
2. AI agents, Knowledge based systems and expert systems
3. Searching algorithms and system optimization, evolutionary computation and genetic algorithms, swarm intelligence and ant colony optimization
4. Neural network architectures and learning rules, Application of neural networks
5. Fuzzy systems and applications, Mamdani-type and Sugeno-type fuzzy systems, type-2 fuzzy systems and fuzzy control
6. Hybrid-intelligence systems, fuzzy-neural networks and applications

32. EE 5081 Operations Research

Learning Outcomes:

On completion of this module, students should be able to

1. play an effective role in providing decision support to managers

Outline Syllabus:

2. Linear and dynamic programming,
3. Sensitivity analysis,
4. Network analysis,
5. Integer programming.

33. EE 5082 Numerical Methods

Learning Outcomes:

On completion of this module, students should be able to

1. understand about numerical methods available for solving complex engineering problems.

Outline Syllabus:

1. Fast Fourier Transforms (FFT),
2. Numerical methods for solving elliptic equations,
3. Finite difference methods,
4. Finite element methods and variational methods,
5. Modal matrix analysis,

34. EE5205 – Control Systems Design

Learning Outcomes

On completion of this module, students should be able to

1. Demonstrate knowledge in different control systems with particular emphasis on their role and importance to industry applications.
2. Mathematically model, analyse and design control systems in state space.
3. Identify and design suitable controllers for industrial applications.
4. Use computer software for control systems design and system simulation.

Outline Syllabus

1. *Overview of fundamentals of control systems:* Introduction to control systems, Mathematical Modelling of Dynamic Systems, Transient and Steady-State Response Analyses, Root-locus Analyses, Frequency response Analyses.

2. *Analysis of control systems in state space*: State-space representation of transfer function systems, Canonical forms, controllability, observability, duality principle.

3. *Design of Control Systems in State space*: Pole placement design, Design of servo systems, State observers, Design of control systems with observers, quadratic optimal regulator systems, MIMO system design.

4. Use of CAD tools to simulate and analyse Control Systems.

35. EE 5209 Mechatronics

Learning Outcomes

On completion of this module, students should be able to

1. Demonstrate and apply the knowledge in identifying, modeling and analyzing different mechatronics systems and practice new technologies in the design of mechatronics systems.
2. Select suitable actuators for mechatronics applications and use them in the design of mechatronics systems.
3. Integrate components of a mechatronics system and interface the system with other controlling devices.
4. Design controllers and estimators for mechatronics applications.

Outline Syllabus

1. *Overview of Mechatronics:* What is Mechatronics, Mechatronic Design Approach, System Interfacing, Instrumentation and Control Systems, Microprocessor-Based Controllers and Microelectronics, An Introduction to Micro- and Nanotechnology, New Directions in Nano-, Micro-, and Mini-Scale Electromechanical Systems Design.

2. *Physical system modeling*: Mechanical, Fluid Power, MEMS.

3. *Actuators*: Piezoelectric Actuators, Hydraulic and Pneumatic Actuation Systems, MEMS.

4. *Interfacing*: Data acquisition and Signal conditioning for Mechatronics applications, AD/DA, Op amps, Power Amplifiers, MATLAB serial communication, MATLAB RTW.

5. *System Controllers and Estimators*: PID control, Adaptive and nonlinear control, Kalman filter, Particle filter, Disturbance observer.

36. EE 5210 Sensors and Actuators for Automation

Learning Outcomes

On completion of this module, students should be able to

1. Identify the crtical specifications of various types of sensors
2. Specify the characteristics of sensors required for an automated system design
3. Specify the characteristics of actuators required for an industrial automation project
4. Design the sensors and actuators needed for a particular automation problem

Outline Syllabus

1. Typical characteristics of sensors in time domain and frequency domain parameters and their relation to the closed loop feedback systems employed in the automation industry
2. *Types of Sensors*: Digital sensors, analog sensors, and sensor specifications
3. *Actuators*: Introduction to different types of actuators including servomotors, dc motors, ac motors, grippers, manipulators, and linear actuators. Hydraulic and pneumatic types
4. Data sampling, A/D, D/A, Interfacing and systems development using sensors and actuators

37. EE 5216 Real-time Systems

Learning Outcomes

On completion of this module, students should be able to

1. Design a real-time control system for industrial control.
2. Design and implement hardware necessary for real-time control.
3. Design software for mission critical applications.
4. Evaluate comparative performance of real-time systems.

Outline Syllabus

1. Fundamentals of Real-time systems
   Evolution of real-time systems, their applications in modern industry, recent advancements.
2. Hardware for real-time systems
   Processor architecture, concurrency, interrupts, process management, memory management, virtual memory, input/output, deadlocks, synchronisation and mutual exclusion, microcontrollers.
3. Real-time operating systems
   Theoretical foundation, scheduling, system services for application programs, selecting real-time OS for a given task, case studies.
4. Development software for real-time systems
   microprocessor programming, requirements of real-time software, software engineering principles, procedural approaches, object oriented approaches,
5. Techniques for performance analysis
   Real-time performance analysis, application of queuing theory, input/output performance, analysis of memory requirements.

38. EE 5217 System Automation Technologies

Learning Outcomes

On completion of this module, students should be able to

1. Understand the basics of automation, automation decision making, principles, and strategies
2. Be able to quantitatively analyse automated systems
3. Understand the theoretical aspects of automation methodologies and technologies
4. Implementation of automated systems using off-the-shelf hardware and turnkey solutions

Outline Syllabus

1. *Background:* Levels of industrial automation, Basic elements of an automated system, Automation principles and strategies
2. *Material Handling and Transport Systems*: Overview of material handling equipments, principles of material handling, AGVs and their control, Conveyor Systems, Analysis of material transport systems
3. *Automatic Identification and Data Capture*: Barcode technologies, RFID technologies and applications, Machine vision technology in ADC applications, Biometric methods
4. *Automated Quality Control Systems*: Methods on quality engineering, ISO 9000, Inspection principles and practices, Inspection technologies (coordinate measuring machines, machine vision, Noncontact non-optical methods)
5. *Automated Assembly Systems*: Design of automated assembly, Quantitative analysis, Visual servoing of robot manipulators

39. EE5105 Applied Power Quality Modelling and Analysis

Learning Outcomes:

At the end of this module, the student should be able to

1. Investigate effects of electromagnetic disturbances on power systems
2. Analyse power quality issues related to electric power systems.
3. Identify proper power quality mitigation techniques
4. Develop solutions as per power quality standards

Outline Syllabus:

1. Network modelling for PQ analysis
2. Load behaviour: distorting loads and non-distorting loads, Harmonic models of transformers, Life time reduction of electrical machines
3. Power quality disturbance allocation: Voltage fluctuations, Transient over voltages; Voltage dips and sags, Voltage unbalance, Harmonics
4. Power quality on Reliability, Relaying and Security
5. Power quality issues with Distributed Generation
6. Power quality monitoring and analysing and reporting
7. Power quality standards
8. power quality economics
9. Mitigation of power quality issues
10. Flexible AC transmission systems (FACTS)

40. EE 5121 Air Conditioning, Ventilation and Fire Safety

Learning Outcomes At the end of this module, the student should be able to 1. Design air conditioning and ventilation systemsfor buildings. 2. Review issues related to performance in air conditioning and ventilation. 3. Design fire protection systems with due regard to precautions necessary against electrical hazards.
Outline Syllabus 1. Principles of air-conditioning and ventilation. 2. Cooling load calculation, major components of air-conditioning & ventilation systems. 3. Handling of refrigerants, air ducts, air distribution and ventilation, fan, AHU, FCU and pump, motor starter and controllers. 4. Maintenance, servicing, testing and commissioning of various types of air conditioning and ventilation systems. 5. Fire theory; design of fire protection systems: fire services automatic sprinkler alarm system; fire hydrant/hose heel systems; pre-action sprinkler system; drencher and water spray systems, automatic & manual alarm system.

41. EE 5212 Systems Control and Automation

Learning Outcomes: On completion of this module, students will be able to 1. Identify, evaluate and model a control system. 2. Implement a control system for a real world application. 3. Select and integrate different modules to work in a microprocessor based environment.
Outline Syllabus: 1. *System modeling and control*: Review of control systems and control techniques, Systems identification and modeling, Feedback control. 2. *Systems Integration*: Sensors and actuators, Signal processing. 3. *Microprocessor based systems*: RISC and CISC architectures, Computer Organization and Control, Peripheral Devices and data communication standards, Operating Systems and Memory Management. 4. SCADA systems and PLCs. 5. AI applications in control and automation.

42. EE5106 Advanced Power System Protection

Learning Outcomes:

At the end of this module, the student should be able to

6. Identify current developments in power system protection including novel methods of fault detection.
7. Use synchronized phasor measurements for power system protection.
8. Apply IEC61850 protocol for substation automation.
9. Simulate advanced protection schemes using computer aided design tools.

Outline Syllabus:

1) Introduction to concepts of power system protection
   - Review of requirements of power system protection.
   - Review of conventional protection schemes.
   - The trends in modern power system protection.
   - Review of digital signal processing for power system protection.
   - Implementation of a digital overcurrent relay in computer aided design software.
2) Identification of power system faults using novel methods.
   - Calculation of fault currents.
   - Methods of identification of fault locations of overhead and underground systems (travelling wave based methods, wavelet based methods, etc)
   - Simulation of a novel fault location identification method in computer aided design software.
3) Power system protection using synchronized phasor measurements.
   - Synchronized phasor measurements and phasor measurement unit architecture.
   - Protection applications of phasor measurements.
   - Implementation of a synchronized phasor measurement based protection scheme in computer aided design software.
4) Introduction to IEC 61850 substation automation protocol and its applications.
   - Brief history of substation automation protocols and IEC 61850.
   - Advantage of Substation Automation with IEC 61850 over conventional control system
   - Key concepts and advancements of IEC 61850.
   - Applications and possible future advancements.

Awards

The **Lanka Transformers Ltd Award** is awarded to the MSc Graduand specializing in Electrical Engineering who has obtained the highest weighted GPA of not less than 3.70, calculated based on 80% of postgraduate examination GPA and 20% of dissertation grade-point, and completes the M Sc degree in the minimum time.

Resource Persons

Lecturers:

Department of Electrical Engineering:

1. Prof. H.Y.R. Perera (Senior Professor)
2. Prof. S.P. Kumarawadu (Professor)
3. Prof. N.K. Wickramarachchi (Professor)
4. Prof. K.T.M.U. Hemapala(Professor)
5. Prof. J.P. Karunadasa (Associate Professor)
6. Eng. W.D.A.S. Wijayapala (Senior Lecturer Gr. I)
7. Dr. D.P. Chandima (Senior Lecturer Gr. I)
8. Dr. A.M.H.S. Abeykoon(Senior Lecturer Gr. I)
9. Dr. W.D.A. S. Rodrigo(Senior Lecturer Gr. I)
10. Dr. A.G.B.P. Jayasekara(Senior Lecturer Gr. I)
11. Dr. T Damayanthi (Senior Lecturer Gr. I)
12. Dr. L.N.W. Arachchige (Senior Lecturer Gr. II)
13. Dr. S K Abeygunawardena(Senior Lecturer Gr. II)
14. Dr. J V U P Jayatunga(Senior Lecturer Gr. II)
15. Dr. R Samarasinghe (Senior Lecturer Gr. II)
16. Dr. W D Prasad (Senior Lecturer Gr. II)
17. R Wijesiriwardhena (Senior Lecturer)

Visiting Staff:

1. Dr. T. Siyambalapitiya, BScEng (Moratuwa), PhD (Cambridge)

   Managing Director ,Resource Management Associates Pvt. Ltd., No 27, Palmyrah Avenue, Colombo
2. Dr. Narendra De Silva, BScEng (Moratuwa), PhD, Head-Engineering, Lanka Electric Company Ltd
3. Dr. H. M. Wijekoon, BScEng (Pera), PhD, Chief Engineer (Transmission Planning), Ceylon Electricity Board

Subject coordinators

CODE	Course Modules	Coordinated by
EE 5092	Research Methodology and Minor Projects	Dr. L.N.W. Arachchige
EE 5117	Electromagnetic Compatibility and Power Quality	Dr. WDAS Rodrigo
EE 5034	Power System Reliability	Prof. HYR Perera
EE 5052	Energy Economics	Dr. WDAS Rodrigo
EE 5093	Power System Planning and Operation	Dr. J V U P Jayatunga
EE 5094	Power System Protection and Stability	Dr. J V U P Jayatunga
EE 5095	Advanced Power Electronics	Prof. JP Karunadasa
EE 5212	Systems Control and Automation	Prof. SP Kumarawadu
EE 5096	Advanced Engineering Mathematics	Prof. KTMU Hemapala
EE 5086	Project Management	Eng. WDAS Wijayapala
EE 5087	Human Resource Management	Prof. V W.ickramasinghe
EE 5118	Building Management Systems	Prof. KTMU Hemapala
EE 5053	Energy Efficiency, Demand Management and Conservation	Dr. J V U P Jayatunga
EE 5123	Lightning Protection and Earthing	Prof. JR Lucas
EE 5091	Small Hydro Project Development	Eng. WDAS Wijayapala
EE 5127	Computer Aided Design (CAD) Tools	Prof. KTMU Hemapala Dr. L.N.W. Arachchige Dr. W. D. Prasad
EE 5124	Procurement and Inventory control	Prof. KTMU Hemapala
EE 5057	Energy and Environment	Eng. WDAS Wijayapala
EE 5097	Variable Speed Drives & Large Electrical Machines	Prof. JP Karunadasa
EE 5102	Power Distribution Systems	Dr. L.N.W. Arachchige
EE 5103	Nuclear Power Engineering	Dr T Damayanthi
EE 5104	Smart Technologies in Power Systems	Prof. KTMU Hemapala
EE 5054	Energy Planning	Dr. WDAS Rodrigo

Recommended by Senate Curriculum and Evaluation Committee meeting held on 20th December 2017

EE 5056	New, Renewable and Rural Energy Systems	Eng. WDAS Wijayapala
EE 5022	Power Supplies and Applications	Prof. JP Karunadasa
EE 5023	Resonant Converters	Prof. JP Karunadasa
EE 5011	DC Motor Drives	Prof. JP Karunadasa
EE 5021	Power Switching Devices	Prof. JP Karunadasa
EE 5028	Power Electronic Converter Harmonics	Prof. JP Karunadasa
EE 5062	Digital Control	Prof. SP Kumarawadu
EE 5209	Mechatronics	Dr. DP Chandima
EE 5210	Sensors and Actuators for Automation	Prof. NK Wickramarachchi
EE 5217	System Automation Technologies	Prof. SP Kumarawadu
EE 5216	Real-time Systems	Prof. NK Wickramarachchi
EE5205	Control Systems Design	Dr. DP Chandima Prof. KTMU Hemapala.
EE 5075	Artificial Intelligence Applications	Dr. AGBP Jayasekara
EE 5082	Numerical Methods	Prof. KTMU Hemapala