**University of Nigeria, Nsukka**

**DEPARTMENT OF ELECTRICAL ENGINEERING**

**POSTGRADUATE PROGRAMMES IN ELECTRICAL ENGINEERING**

**PHILOSOPHY**

The Electrical Engineering Postgraduate Programme is established to make contributions to the advancement of Electrical Engineering knowledge, skill and practice. These contributions are made by the offering of advanced course programme, the carrying out of research work and the sharing of knowledge and research results through interactions/communications with fellow electrical engineers the world over.

**OBJECTIVES**

The Postgraduate Training is in three major areas namely, Power Devices and Systems, Power Systems and High Voltage Engineering, Automatic Control Systems. The programme is designed to produce proficient higher degree holders in several specialist areas of Electrical Engineering. The postgraduate candidate, before being awarded a higher degree, have to prove himself/herself (by his/her performance in the courses and research work) to have acquired advanced knowledge, skill and research techniques to be professionally competent and/or capable of contributing new ideas and improved methods to the teaching and practice of electrical engineering.

**SCOPE OF WORK**

The scope of work depends on the higher degree in which a candidate is enrolled.

Each higher degree has a stipulated mode of study outlined as follows:

1. **Mode of Study for the Master of Engineering (M.Eng) Programme**

The study for the Master’s degree in Electrical Engineering is by course work of 21 credit hours to be examined in written papers together with 6 credit hours for Master’s project work while 3 credit hours is for seminar. Similarly,the PG general course PGC 610– Research methodology and ICT in Engineering which is compulsory for every master student is already included in above 21 credit hours but all the students should participate in workshop that will be organized by the PG school as a perquisite for the examination. Hence, the minimum credit hours for master is 30.

1. **Mode of Study for the Doctor of Philosophy (Ph .D) Programme.**

A Ph.D candidate will be required to take 12 credit hours of coursework based on candidate’s research topic/area including a 3 unit PGcourse on Synopsis and Research Grant Writing, also 12 credit hours is for the Ph. D thesis. Also, 6 units for two seminars, one presented as Research Proposal at the beginning of the student’s research programme and the other, at the end of the research work before the final oral defense. Workshop on Synopsis and Research Grant Writing will be organized by SPGS as a perquisite for examination on the courses. Hence, the total minimum credit hour for Ph.D student in the department is 30.

**ADMISSION REQUIREMENTS:** The minimum entry requirement for the postgraduate programme in Electrical Engineering is a goodrequisite degree or its equivalent in a recognized institution.

1. **M.ENG. Programmes**

The minimum entry requirement for Master’s degree for graduates of the University of Nigeria or of other recognized Universities who obtained the approved degree of bachelor with at least a good Second Class Honours (Bachelor’s) degree in Electrical and/or Electronic Engineering or the equivalent with not less than 2.50 on a 5-point scale, or its equivalent. Candidates deficient in some areas of the discipline will be required to take remedial undergraduate courses approved by the Department.

b.. **Doctor of Philosophy (Ph.D) Programme**

Graduates of the University of Nigeria or other recognized Universities who have good Master’s degree or its equivalent in Electrical and/or Electronic Engineering are qualified to apply for provisional registration as candidates with the degree of Doctor of Philosophy (Ph.D) in view. Such a candidate should has a minimum GPA of 3.0 on a 4.0 point scale or 3.50 on a 5.0 point scale in his/her Master’ degree. A candidate already registered for the Master’s Programme will normally be required to complete the Master’s Degree Programme before applying for the Ph.D Programme. However, provisional registration for the Ph.D Programme may be approved for a Master’s degree student based on an exceptional performance assessed over a period of at least two semesters of the Master’s Programme.

**AREAS OF SPECIALIZATION: B. BNG. AND Ph.D**

Postgraduate courses are in five major areas as follows:

1. Power Electronics, Drives and New Energy Systems
2. Electrical Machines and Drives
3. Electromagnetic Fields and Applications
4. Power Systems and High voltage Engineering
5. Automatic Control Systems

**DURATION OF PROGRAMMES**

Maximum and minimum duration of Postgraduate Diploma programme shall be:

**M. ENG.**

Full-Time: A minimum of 4 Semesters A maximum of 6 Semesters

Part-Time: A minimum of 6 Semesters A maximum of 8 Semesters

**PhD**

Full-Time: A minimum of 6 Semesters A maximum of 10 Semesters

Part-Time: A minimum of 8 Semesters

 A maximumof 12 Semesters

The first two semesters of the Doctoral programme shall be devoted to course work and written examinations, the remaining sessions for thesis, and seminars

**Requirements for graduation**

**M.A. Programme**

I) To be awarded the M.ENG. degree a student must have taken and passed the prescribed number of compulsory and required courses selected from the approved list, a total of 30 units as follows:

Core courses 24 units

Thesis/Dissertation 6 units

Total 30 units

II. There are compulsory courses for the Master’s Programme while the rest of the courses are

 selected based on the student’s area(s) of interest. Depending on the students’ research interest,

courses can be selected from related disciplines such as Electronics Engineering, Computer

 Science etc. All selected courses must have the approval of the students’ academic supervisor(s)

and the Department.

 In all cases of M.ENG. students, a research/project topic is selected with the cooperation and

 advice of the academic supervisor and every student must write and submit to the department a

projecr report duly supervised by a lecturer in the department whose qualifications are not below

the Ph.D. There will be a seminar (at least one) to appraise on-going research/project work before

 the submission of a final write-up on the research work for examination.Such a projecr report must

be sent to an external examiner nominated by the department and appointed bySenate for that

 purpose and a date will be fixed for oral defense when the student will defend his/her work in the

 presence of external examiner and departmental board.

**Ph.D. Programme**

To graduate, all the Ph.D. candidates must take and pass all the requisite courses as prescribed in the Ph.D course list below, a total of 30 units as follows:

Core Courses 12 units

2 Seminars 6 units

Thesis 12 units

Total 30 units

Every Ph.D. candidate must submit a thesis on a chosen and approved topic, supervised by a member of staff whose qualification is not below the Ph.D, and who is not lower than Senior Lecturer in rank.

The Ph.D. thesis must be defended before an external examiner dully nominated for that purpose and appointed by Senate.

**LIST OF APPROVED SUPERVISORS**

**PROFESSORS**

S. E. Obe Electrical Machines and Drives

B.Eng, M.Eng.Ph.D (Nig)

**(Supervising M.Eng&Ph.D)**

E. C. Ejiogu Industrial Electronics (Including Power

B.Eng, M.Eng(Nig) Ph.D(Shinshu, Japan) Electronics), Electric Motor Drives and New

**(Supervising M.Eng&Ph.D)** Energy Systems

T. C. Madueme High Voltage Engineering, Power Systems

M.Sc (Sweden), Ph.D(Nig) & Energy Studies

**(Supervising M.Eng&Ph.D)**

L. U. Anih Electrical Machines and Drives

B.Eng(ASUTECH), M.Sc (Ife), Ph.D (Nig)

**(Supervising M.Eng&Ph.D)**

 A. O. Ekwue Power Systems and Protections

B. SC (UNN) Ph. D (UK)

**(Supervising M.Eng&Ph.D)**

**SENIOR LECTURERS**

C. I. Odeh Power Electronics, Drives and New

B.Eng, M.Eng., Ph.D (Nig) Energy Systems

**(Supervising M. Eng)**

C.M. Nwosu Power Electronics, Drives, Control & New

B. Eng, M. Eng., Ph.D (Nig) Energy Systems

**(Supervising M. Eng)**

D. B. N. Nnadi Power Electronics, Drives and New Energy

B.Eng, (ESUT), M.Eng.(ESUT), Ph.D (Nig) Systems

**(Supervising M. Eng)**

C. U. Ogbuka Electric Machines, and Drives

B.Eng, M.Eng., Ph.D (Nig)

**(Supervising M. Eng)**

B. O. Anyaka Power Systems/Applied Automatics

B. Eng/ M.Eng, Ph. D (Nig)

**(Supervising M. Eng)**

**LECTURER I**

S. E. Oti Electrical Machines and Drives

B.Eng, M.Eng., Ph.D (Nig)

**(Supervising M. Eng)**

**U. C. Ogbuefi** Power System and High Voltage

B. Eng(Uniport), PGD (RSUT), Ph.D (Nig)

**(Supervising M. Eng)**

**C. U. Eya** Power Electronics, Drives and New Energy

B.Eng, M.Eng., Ph.D (Nig) Systems

**(Supervising M. Eng)**

**EMPLOYMENT OPPORTUNITIES**

Employment opportunities in Electrical Engineering are many and varied. This is because of the need for electric power and electric machines/equipment in virtually all establishments. The opportunities include the following:

(a) Research, product/system design and development in manufacturing companies

(b) Research, design, development, installation, operation and maintenance of ElectricalSystems

(Utility Electrical Power Network, Communication Network, Computer SystemNetwork, Electric

Control Centers etc.).

(c) Teaching/Research and Consultancy Services in Public Institutions and Private Establishments.

AREAS OF SPECIALIZATION

**STRESS AREAS CODES**

General/Compulsory 0

Power Electronics and Devices 1

Electrical machines 2

Power Systems& High Voltage Engineering 3

Automatic Control Systems 4

M.Eng Project Report 5

Ph.D Thesis 6

**Listing of Courses and Research Types for M.Eng**

**Power Electronics, Devices and New Energy Systems - M.Eng**

**First Semester**

**Courses No. Title Credit Units**

EEE 601 Advanced Methods of Analysis in Electrical Engineering 3

PGC601 Research Methodology and ICT in Engineering 3

EEE 612 Advanced Semiconductor Power Circuits 3

 (Candidate should choose any one of EEE631 or EEE 621) 3

 **Total 12 Units**

**Elective**

EEE 631 Advanced Theory of Control Systems 3

EEE 621 Power System Analysis 3

**Second Semester**

EEE 614 Electric Drives 3

EEE 616 Logic Control Circuits in Power Engineering 3

EEE 613 Electro-heat Processes 3

EEE 602 Seminar 3

EEE 651 M. Eng. Project Report 6

  **Total 18 Units**

 **Total Required 30 Units**

**Power Electronics, Devices and New Energy Systems Option - Ph. D**

**First Semester (Compulsory Course) Units**

PGC701 Synopsis and Research Grant Writing 3

EEE 701 Special Topics in Static A.C Machine Control 3

 **Total 6**

**Second Semester Units**

EEE 712 Advanced Application of Power Converters 3

EEE 713 Advanced Electro-heat processes 3

EEE703 Seminar I (Proposal) 3

EEE 704 Seminar II 3

EEE 751 Ph.D Thesis 12 **Total 24**

 **Total Required 30**

**MASTER’S COURSE DESCRIPTION IN POWER ELECTRONICS DEVICES AND NEW ENERGY SYSTEMS**

**EEE 601 – Advanced Methods of Analysis in Electrical Engineering**

Review of Matrices.Time domain and transfer techniques for linear continuous and discrete-timesystems.State variable methods.State transition matrix for time- invariant and time-varyingcontinuous and discrete systems.Adjoint Systems.Singularityfunctions and superpositionintegrals for linear systems.Fourier,Laplace, Z-transform and generalized transform techniques.Introduction to controllability,observability, and stability.Distributed parameter system analysis. Transfer function, integralequation representation, and state model for selected control systems. Selected numericalanalysis methods and applications —3 credits

**PGC 601: Research Methodology and ICTIn Engineering**

Use of advanced analytical tools like MATLAB/SIMULINK, SCILAB/XCOS, etc. for solution of engineering problems and their applications *(Application of these soft wares depends on the various problems formulated in different departments).*Information literacy, information sources (media, publishers, agreggators); validity of information, plagiarism and legal aspects.

Information search – search engines, journal repositories, academic (social) networks, search strategies, personal contacts, tools for managing references.

Integrating information literacy in research, cloud computing, audiovisual tools, e.g powerpoint presentations.

Literature review: Reading and summarizing relevant articles, critical analysis and evaluation of research, identification of themes and comparators, writing review documents and identification of research (or knowledge) gaps.

Scientific method and nature of evidence: Experimental methods and design methods *(as may be applicable to individual departments and research areas)*, data collection and management of quantitative data. Human participants – expert reviews, focus groups, questionnaires and interviews.

Project management and report writing: project planning, report structure and style, general report writing techniques. **– 3 Credit Units**

**EEE 612 – Advanced Semiconductor Power Circuits**

Two pulse, six pulse, twelve pulse and twenty-four pulse rectifier circuits. Fixed and variablefrequency AC controllers. DC to DC step-up or step-down converters.Adjustable voltageadjustable frequency inverters. Pulse-width modulated inverters. Current-fed inverters.Elimination of undesired harmonics in power converters. **– 3 credit Units**

**EEE 602 Seminar**

A written presentation of modeling, Simulation and Laboratory validations of the candidate’s topic modelling which is baed on candiadte’s area of specialization  **- 3 Credit Units**

**EEE 613 Electro-Heating Processes**

Resistance heating.Three-phase and two-phase electrode arc furnaces.Types of inductionheating furnaces. Frequency selection in induction heating power supplies: mains frequency,mains frequency triplers, motor generator sets and variable frequency inverters andcyclo-inverters. **– 3 credit units.**

**EEE 614 – Electric Drives**

Rectifier-fed DC motors. Chopper-fed DC motors. Design and applications of DC drives.Classification, analysis and control of AC drives.Design and applications of AC drives.Microprocessors in industrial drives. **- 3 credit units.**

**EE 616 – Logic Control Circuits in Power Engineering**

Digital logic families, linear integrated circuit components, small signal discrete components andtheir main specifications. Common transducers, Microprocessor programmed logic. Design offiring/gating logic circuits for controlled rectifiers, inverters, choppers and cyclo-converters.Design of voltage, current, power and frequency regulation circuits for motor drives and powersupplies. Microprocessor-based logic control methods **– 3 credit units.**

**EEE 621 – Power System Analysis**

The Power Flow Problem:- numerical methods for solution of AC and DC models of the powersystem. Analysis of faulted power systems: balanced and unbalanced faults, Symmetrical

Components, Sequence impedances of power system components - transmission lines,synchronous, machines, and transformers; series and shunt faults, simultaneous faults.Power System Stability:- Analysis of steady-state stability of simple and complex powersystems. **-3 credit units.**

**EEE 631 – Advanced Theory of Control System.**

Review of the techniques of obtaining the time response of linear systems, Nyquist and Routh-Hurwits stability criteria, Bode diagrams, Analysis of piecewise linear system and second ordernon-linear system, method of Isoclines, describing functions and Tsypkin locus, generalization oflyapunov function by lurie and variable gradient techniques; Popov criteria. **- 3 credit hours.**

**EEE 651 Project Report**

Students are required to conduct a comprehensive research on a problem topic that should be classified in this stress area. The research must be modelled, simulated using any of the available or approved Soft ware (MATLAB/SIMULINK) and a laboratory validation is required.The research report should follow a specified documentation pattern.  **– 6 Credit Units**

**Ph.D COURSE DESCRIPTION IN POWER ELECTRONICS DEVICES AND NEW ENERGY SYSTEMS**

**PGC 701: Research Grant Technical/Synopsis Writing**

Choice of broad research area with considerations of interdisciplinary topics, Identification of research/ knowledge gaps and research objectives.

Role of technical reports in engineering projects. Fundamental principles of technical writing.Format of different types of reports, outlines, purpose and scope, technical discussion details, role of appendix, function of figures, equation editors, tables and illustration.Literature search, references (citing’s and listings).Nature of recommendations and conclusions.Guides for writing memoranda, business letters.Oral presentation of technical reports and thesis. Synopsis writing

Developing long-term research plan, Identification of potential funding agencies and their requirements.Research objectives in relation to interests of the funding agencies.Estimating research timelines, Budget preparation, manpower requirements and availability, research facilities, legal issues, etc. **-3 Credit Units**

**EEE 701 Special Topics in Static A.C Machine Control**

Direct and Indirect torque and speed control, Field orientation in induction and synchronous motor drives, Sensor-less motor drive techniques, Permanent and brushless DC motor drive techniques. **– 3 Credit Units**

**EEE712 Advanced Application of Power Converters**

Special converter circuits, modular connected converters, Low and High power converters, Static VAR compensators, Renewable Energy in Distributed Utility Systems. **-3 Credits Units**

**EEE 713 Advanced Electro-heat processes**

Characteristics of Medium frequency induction heating, Radio- frequency induction heating, Electric-field based theory of induction heating, Heat transfer in induction heating, Economic and thermal efficiencies of induction heating sources. Special applications of induction heating.

 -**3 Credit Units**

**EEE703 Seminar I – Proposal**

It is expected that each doctoral candidate shall present at least first three chapters of the thesis in a proposal detailing the problem of syudt, the study background, main aim, objectives, literature review, and the methodology to be adopted for the study. In applicable cases, a very clear model of the system or sitiiation to be studied is presented. -**3 Credit Units**

**EEE704:Seminar 2 – Research Findings**

A second seminar detailing the results obtained (research findings) from EEE 703 and maing useful contributions and valued added to the existing knowledge is presented here. The entire complete thesis would have been submitted to the department for reading in which all grey areas should be cleared. Candidate will then write a synopsis and proceed for oral examinations by the external examiner. -**3 Credit Units**

**EEE751 Thesis**

Each candidate for a Doctoral degree shall be assigned a suitable research project approved by the Departmental Postgraduate Studies Committee. The research topic should be ground breaking, thought provoking and must contribute veritably to existing frontiers of knowledge in the area of candidates choice. The results of the research shall be embodied in the thesis. -**12 Credit Units**

**Electrical Machines& Drives - M.Eng**

 **First Semester**

**Courses No. Title Credit Units**

EEE 601 Advanced Methods of Analysis in Electrical Engineering 3

PGC601 Research Methodology and ICT in Engineering 3

EEE 611 Theory and Modeling of Electrical Machines 3

(Candidate should choose any one of EEE631 or EEE 621) 3

 **Total 12**

**Elective**

EEE 631 Advanced Theory of Control Systems 3

EEE 621 Power System Analysis 3

EEE 617 Electromagnetic Fields Analysis 3

EEE 619 Special Applications of Electromagnetic Fields 3

**Second semester**

EEE 615 Special Topics in Electrical Machines 3

EEE 614 Electric Drives 3

EEE 618 Advanced Electric Machine Design 3

EEE 602 Seminar 3

EEE 651 M. Eng. Project Report 6

 **Total 24**

 **Total Required 30**

**Electrical Machines & Drives – Ph. D**

**First Semester Units**

PGC701 Synopsis and Research Grant Writing 3

EEE 701 Special Topics in Static A.C Machine Control 3

 **Total 6**

**Second Semester**

EEE 711 Advanced Theory & Modeling of Electrical Machines 3

EEE 715 Advanced Special Topics in Electrical Machines 3

EEE 703 Seminar I (Proposal) 3

EEE 704 Seminar II 3

EEE 751 Ph.D Thesis 12 **Total 24**

 **Total Required 30**

**MASTER’S COURSE DESCRIPTION IN ELECTRICAL MACHINES & DRIVES**

**EEE 601 – Advanced Methods of Analysis in Electrical Engineering**

Review of Matrices.Time domain and transfer techniques for linear continuous and discrete-timesystems.State variable methods.State transition matrix for time- invariant and time-varyingcontinuous and discrete systems.Adjoint Systems.Singularityfunctions and superpositionintegrals for linear systems.Fourier,Laplace, Z-transform and generalized transform techniques.Introduction to controllability,observability, and stability.Distributed parameter system analysis. Transfer function, integralequation representation, and state model for selected control systems. Selected numericalanalysis methods and applications **—3 Credit Units**

**PGC 601: Research Methodology and ICTIn Engineering**

Use of advanced analytical tools like MATLAB/SIMULINK, SCILAB/XCOS, etc. for solution of engineering problems and their applications *(Application of these soft wares depends on the various problems formulated in different departments).*Information literacy, information sources (media, publishers, agreggators); validity of information, plagiarism and legal aspects.

Information search – search engines, journal repositories, academic (social) networks, search strategies, personal contacts, tools for managing references.

Integrating information literacy in research, cloud computing, audiovisual tools, e.g powerpoint presentations.

Literature review: Reading and summarizing relevant articles, critical analysis and evaluation of research, identification of themes and comparators, writing review documents and identification of research (or knowledge) gaps.

Scientific method and nature of evidence: Experimental methods and design methods *(as may be applicable to individual departments and research areas)*, data collection and management of quantitative data. Human participants – expert reviews, focus groups, questionnaires and interviews.

Project management and report writing: project planning, report structure and style, general report writing techniques. **– 3 Credit Units**

**EEE 602 Seminar**

A written presentation of modeling, Simulation and Laboratory validations of the candidate’s topic modelling which is baed on candiadte’s area of specialization  **- 3 Credit Units**

**EEE 611 – Theory & Modeling of Electrical Machines**

Equivalent circuits of complex magnetic systems, transformer frequency-dependent equivalentcircuits, inrush currents, DQ representation of AC. Machines (induction machines, synchronousmachines, reluctance machines etc.)AC machine dynamics using dq models. Special characteristic features of dc and ac machines. **–3 Credits Units**

**EEE 614 – Electric Drives**

Rectifier-fed DC motors. Chopper-fed DC motors. Design and applications of DC drives.Classification, analysis and control of AC drives.Design and applications of AC drives.Microprocessors in industrial drives. **- 3 Credit Units.**

**EEE 615 – Special Topics in Electrical Machines**

Some special transformation devices such as instrument transformers, direct current transducersand saturable reactors. Permanent magnet dc motors. Synchros. Linear induction motors. Ironcoredand air-cored linear synchronous motors. Variable reluctance and permanent magnetstepping motors.Field pattern plotting methods in electrical machines. **- 3 Credits Units**

**EEE 617 – Electromagnetic Field Analysis**

Review of Vector arithmetic, vector algebra and vector calculus. Electric field calculations.Energy and potential due to distributed and line charges. Conductor and dielectric properties andboundary conditions.Experimental field mapping methods.Poisons and Laplace equations. Thesteady magnetic field, magnetic forces materials and inductance. Time varying fields andMaxwell’s equations.The Poynting vector and power considerations.Field propagation in goodconductors and skin effect.Use of field equations in determining transmission line parameters. **–3 Credit Units.**

**EEE 618 – Advanced Electric Machine Design.**

Magnetic Core Material types, characteristics and .applications; M insulation types andapplications; Electric machine cooling methods.Elements of inductor design and construction;Transformer design and construction. DC and AC machine design techniques. **- 3 Credit Units.**

**EEE 619 – Special Applications of Electromagnetic fields**

Computer aided steady state and transient solutions of selected field problems in inductiondevices. Electric induction pumps. Methods of Electromagnetic stirring.transportation andpouring of molten metals for continuous casting. Levitation principles. Eddy current distributionin and power transferred to a work piece in contactless heating. Metal circulation and inducedcurrents in electrode arc furnaces. Current, force and/or velocity distributions in channel andcoreless furnaces. **– 3 Credit Units.**

**EEE 621 – Power System Analysis**

The Power Flow Problem:- numerical methods for solution of AC and DC models of the powersystem. Analysis of faulted power systems: balanced and unbalanced faults, Symmetrical

Components, Sequence impedances of power system components - transmission lines,synchronous, machines, and transformers; series and shunt faults, simultaneous faults.Power System Stability:- Analysis of steady-state stability of simple and complex powersystems.

 **-3 Credit Units.**

**EEE 631 – Advanced Theory of Control System.**

Review of the techniques of obtaining the time response of linear systems, Nyquist and Routh-Hurwits stability criteria, Bode diagrams, Analysis of piecewise linear system and second ordernon-linear system, method of Isoclines, describing functions and Tsypkin locus, generalization oflyapunov function by lurie and variable gradient techniques; Popov criteria. **- 3 Credit Units.**

**EEE 651 Project Report**

Students are required to conduct a comprehensive research on a problem topic that should be classified in this stress area. The research must be modelled, simulated using any of the available or approved Soft ware (MATLAB/SIMULINK) and a laboratory validation is required.The research report should follow a specified documentation pattern. **– 6 Credit Units**

**Ph.D COURSE DESCRIPTION IN ELECTRICAL MACHINES & DRIVES**

**PGC 701: Research Grant Technical/Synopsis Writing**

Choice of broad research area with considerations of interdisciplinary topics, Identification of research/ knowledge gaps and research objectives.

Role of technical reports in engineering projects. Fundamental principles of technical writing.Format of different types of reports, outlines, purpose and scope, technical discussion details, role of appendix, function of figures, equation editors, tables and illustration.Literature search, references (citing’s and listings).Nature of recommendations and conclusions.Guides for writing memoranda, business letters.Oral presentation of technical reports and thesis. Synopsis writing

Developing long-term research plan, Identification of potential funding agencies and their requirements.Research objectives in relation to interests of the funding agencies.Estimating research timelines, Budget preparation, manpower requirements and availability, research facilities, legal issues, etc. **-3 Credit Units**

**EEE 701 Special Topics in Static A.C Machine Control**

Direct and Indirect torque and speed control, Field orientation in induction and synchronous motor drives, Sensor-less motor drive techniques, Permanent and brushless DC motor drive techniques. **– 3 Credit Units**

**EEE 711 –Advanced Theory& Modeling of Electrical Machines**

The theory of Winding Functions and its applications to Inductance calculations.Finite element modeling of magnetic circuits. Theory of reference frames as they apply to high phase order ac machines. Modelling of qual winding electrical machines.Fault-tolearant electrical machines.Field weakning operation of electrical machines.Development of Equivalent circuits of complex magnetic systems. **– 3 credits Units**

**EEE 715 – Advanced Special Topics in Electrical Machines**

Some special transformation devices such as instrument transformers- Current Transformers & Voltage transformers, direct current transducers and saturable reactors. Permanent magnet dc motors. Synchros. Linear induction motors. Ironcored and air-cored linear synchronous motors. Variable reluctance and permanent magnet stepping motors.Field pattern plotting methods in electrical machines. **- 3 credits Units**

**EEE703 Seminar I – Proposal**

It is expected that each doctoral candidate shall present at least first three chapters of the thesis in a proposal detailing the problem of syudt, the study background, main aim, objectives, literature review, and the methodology to be adopted for the study. In applicable cases, a very clear model of the system or sitiiation to be studied is presented. -**3 Credit Units**

**EEE704:Seminar 2 – Research Findings**

A second seminar detailing the results obtained (research findings) from EEE 703 and maing useful contributions and valued added to the existing knowledge is presented here. The entire complete thesis would have been submitted to the department for reading in which all grey areas should be cleared. Candidate will then write a synopsis and proceed for oral examinations by the external examiner. -**3 Credit Units**

**EEE751 Thesis**

Each candidate for a Doctoral degree shall be assigned a suitable research project approved by the Departmental Postgraduate Studies Committee. The research topic should be ground breaking, thought provoking and must contribute veritably to existing frontiers of knowledge in the area of candidates choice. The results of the research shall be embodied in the thesis. -**12 Credit Units**

**Power Systems and High Voltage Engineering – M. Eng**

**First Semester**

**Courses No. Title Credit Units**

EEE 601 Advanced Methods of Analysis in Electrical Engineering 3

PGC601 Research Methodology and ICT in Engineering 3

EEE 621 Power System Analysis 3

(Candidate should choose any one of EEE611 or EEE 612) 3

 **Total 12**

**Second Semester**

EEE 628 High Voltage Engineering 3

EEE 625 Economic Operation of Power System 3

EEE 623 Power System Planning and Optimization 3

EEE 602 Seminar 3

EEE 651 M. Eng. Project Report 6

 **Total 18**

 **Total Required 30**

**Elective Courses**

EEE 622 Power System Control and Protection 3

EEE 624 Power System Distribution 3

EEE 626 Power System Dynamics 3

EEE 627 DC Transmission 3

**Power Systems and High Voltage Engineering – Ph. D**

**First Semester Units**

PGC701 Synopsis and Research Grant Writing 3

EEE 701 Special Topics in Static A.C Machine Control 3

 **Total 6**

**Second Semester**

EEE 724 Advanced Power System Distribution 3

EEE 726 Advanced Power System Dynamics 3

EEE 703 Seminar I (Proposal) 3

EEE 704 Seminar II 3

EEE 751 Ph.D Thesis 12 **Total 24**

 **Total Required 30**

**MASTER’S COURSE DESCRIPTION IN POWER SYSTEMS AND HIGH VOLTAGE ENGINEERING**

**EEE 601 – Advanced Methods of Analysis in Electrical Engineering**

Review of Matrices.Time domain and transfer techniques for linear continuous and discrete-timesystems.State variable methods.State transition matrix for time- invariant and time-varyingcontinuous and discrete systems.Adjoint Systems.Singularityfunctions and superpositionintegrals for linear systems.Fourier,Laplace, Z-transform and generalized transform techniques.Introduction to controllability,observability, and stability.Distributed parameter system analysis. Transfer function, integralequation representation, and state model for selected control systems. Selected numericalanalysis methods and applications **—3 Credit Units**

**PGC 601: Research Methodology and ICTIn Engineering**

Use of advanced analytical tools like MATLAB/SIMULINK, SCILAB/XCOS, etc. for solution of engineering problems and their applications *(Application of these soft wares depends on the various problems formulated in different departments).*Information literacy, information sources (media, publishers, agreggators); validity of information, plagiarism and legal aspects.

Information search – search engines, journal repositories, academic (social) networks, search strategies, personal contacts, tools for managing references.

Integrating information literacy in research, cloud computing, audiovisual tools, e.g powerpoint presentations.

Literature review: Reading and summarizing relevant articles, critical analysis and evaluation of research, identification of themes and comparators, writing review documents and identification of research (or knowledge) gaps.

Scientific method and nature of evidence: Experimental methods and design methods *(as may be applicable to individual departments and research areas)*, data collection and management of quantitative data. Human participants – expert reviews, focus groups, questionnaires and interviews.

Project management and report writing: project planning, report structure and style, general report writing techniques. **– 3 Credit Units**

**EEE 602 Seminar**

A written presentation of modeling, Simulation and Laboratory validations of the candidate’s topic modelling which is baed on candiadte’s area of specialization  **- 3 Credit Units**

**EEE 611 – Theory & Modeling of Electrical Machines**

Equivalent circuits of complex magnetic systems, transformer frequency-dependent equivalentcircuits, inrush currents, DQ representation of AC. Machines (induction machines, synchronousmachines, reluctance machines etc.)AC machine dynamics using dq models. Special characteristic features of dc and ac machines. **–3 credits Units**

**EEE 612 – Advanced Semiconductor Power Circuits**

Two pulse, six pulse, twelve pulse and twenty-four pulse rectifier circuits. Fixed and variablefrequency AC controllers. DC to DC step-up or step-down converters.Adjustable voltageadjustable frequency inverters. Pulse-width modulated inverters. Current-fed inverters.Elimination of undesired harmonics in power converters. **– 3 Credit Units**

**EEE 621 – Power System Analysis**

The Power Flow Problem:- numerical methods for solution of AC and DC models of the powersystem. Analysis of faulted power systems: balanced and unbalanced faults, Symmetrical

Components, Sequence impedances of power system components - transmission lines,synchronous, machines, and transformers; series and shunt faults, simultaneous faults.Power System Stability:- Analysis of steady-state stability of simple and complex powersystems. **-3 Credit Units.**

**EEE 622 – Power System Control and Protection**

Relay principles and types, instrumentation for system parameters, relay characteristics, andresponses, system component, protection, solid-state relaying, under frequency relays, load-shedding,elements of high power circuit interruption, circuit breakers, types and problems.Power system control principles and communications. **- 3 Credit Units**.

**EEE 623 – Power System Planning and Optimization**

Power system components functions, application and performance. Relative cost and scalingparameters, over-all planning problem considering present worth and cost-benefit principles,system reliability, load forecasting. Non-linear programming- unconstrained and constrainedminimization methods. Lagrange multi-pliers, Kuhn-Tucker conditions, Linear, quadratic andinteger programming. Applications of optimization techniques to power systems - e.g. economicdispatch, optimal load shedding, transmission planning etc**. - 3 Credit Units.**

**EEE 624 – Power System Distribution:**

Objectives and basic definitions.Standard specifications of cables, transformers and distributionvoltages.Code applications with regards to conductors, protection and equipment.Utility systemdistribution. Consumer premises distribution. Engineering problems and environmentalconsiderations.Power measurements and billings.Trends for the future. **-3 Credit Units.**

**EEE 625 – Economic Operation of Power Systems**

Concepts of economic operation — Unit characteristics and economical operation, transmissionloss coefficients, general loss formula, generator scheduling - automatic economic loaddispatch, Models for inter-change and for multi-area dispatch, operating security, Resourcemodeling and hydro-thermal coordination. **-3 Credit Units.**

**EEE 626 - Power System Dynamics**

The dynamic characteristics and control requirements of power systems are introduced. Consideration is given to the detailed modeling of synchronous machines and its controls such as excitation systems and turbine-governor; power system loads; load-frequency control; power exchange between networks etc. Time scales and reduced order models; non-linear and linear multi-machine models etc. The modeling and control requirements will be discussed for small and large disturbances as well as voltage stability studies. Methodologies, tools and techniques for performing these studies will be introduced **- 3 Credit Units.**

**EEE 627 – DC Transmission**

Advantages of dc systems; converter bridge circuits and system parameters; compounding andregulation; fault consideration and system protection; application of dc transmission as aneconomic system component, and method of improving a.c. system dynamics**. – 3 Credit Units.**

**EEE 628 – High Voltage Engineering**

High Voltage generation and measurements: testing transformer set, d.c. multiplier circuits.Impulse generation analysis and testing, safety practices. Dielectric phenomena dielectric lossevaluation, discharge detection and measurement. Elements of high power circuit interruption,circuit and physical phenomena, circuit breakers, types and problems. **– 3 Credit Units.**

**EEE 651 Project Report**

Students are required to conduct a comprehensive research on a problem topic that should be classified in this stress area. The research must be modelled, simulated using any of the available or approved Soft ware (MATLAB/SIMULINK) and a laboratory validation is required.The research report should follow a specified documentation pattern.  **– 6 Credit Units**

**PH.D’S COURSE DESCRIPTION IN POWER SYSTEMS AND HIGH VOLTAGE ENGINEERING**

**PGC 701: Research Grant Technical/Synopsis Writing**

Choice of broad research area with considerations of interdisciplinary topics, Identification of research/ knowledge gaps and research objectives.

Role of technical reports in engineering projects. Fundamental principles of technical writing.Format of different types of reports, outlines, purpose and scope, technical discussion details, role of appendix, function of figures, equation editors, tables and illustration.Literature search, references (citing’s and listings).Nature of recommendations and conclusions.Guides for writing memoranda, business letters.Oral presentation of technical reports and thesis. Synopsis writing

Developing long-term research plan, Identification of potential funding agencies and their requirements.Research objectives in relation to interests of the funding agencies.Estimating research timelines, Budget preparation, manpower requirements and availability, research facilities, legal issues, etc. **-3 Credit Units**

**EEE 701 Special Topics in Static A.C Machine Control**

Direct and Indirect torque and speed control, Field orientation in induction and synchronous motor drives, Sensor-less motor drive techniques, Permanent and brushless DC motor drive techniques. **– 3 Credit Units**

**EEE 724 – Advanced Power System Distribution:**

Regulations concerning power distribution, Standard specifications of cables, transformers and distribution voltages.Code applications with regards to conductors, protection and equipment.Utility system distribution. Consumer premises distribution. Engineering problems and environmental considerations.Power measurements and billings.Trends for the future.  **- 3 Credit Units.**

**EEE 726 - Power System Dynamics**

The dynamic characteristics and control requirements of power systems are introduced. Consideration is given to the detailed modeling of synchronous machines and its controls such as excitation systems and turbine-governor; power system loads; load-frequency control; power exchange between networks etc. Time scales and reduced order models; non-linear and linear multi-machine models etc. The modeling and control requirements will be discussed for small and large disturbances as well as voltage stability studies. Methodologies, tools and techniques for performing these studies will be introduced **- 3 Credit Units**

**EEE703 Seminar I – Proposal**

It is expected that each doctoral candidate shall present at least first three chapters of the thesis in a proposal detailing the problem of syudt, the study background, main aim, objectives, literature review, and the methodology to be adopted for the study. In applicable cases, a very clear model of the system or sitiiation to be studied is presented. -**3 Credit Units**

**EEE704:Seminar 2 – Research Findings**

A second seminar detailing the results obtained (research findings) from EEE 703 and maing useful contributions and valued added to the existing knowledge is presented here. The entire complete thesis would have been submitted to the department for reading in which all grey areas should be cleared. Candidate will then write a synopsis and proceed for oral examinations by the external examiner. -**3 Credit Units**

**EEE751 Thesis**

Each candidate for a Doctoral degree shall be assigned a suitable research project approved by the Departmental Postgraduate Studies Committee. The research topic should be ground breaking, thought provoking and must contribute veritably to existing frontiers of knowledge in the area of candidates choice. The results of the research shall be embodied in the thesis. -**12 Credit Units**

**AUTOMATIC CONTROL SYSTEMS – M. Eng**

**Courses No. Title Credit Units**

EEE 601 Advanced Methods of Analysis in Electrical Engineering 3

PGC601 Research Methodology and ICT in Engineering 3

EEE 631 Advanced Theory of Control Systems 3

EEE 611 Theory and Modeling of Electrical Machines 3

 **Total 12**

**Second Semester**

Candidates should choose either EEE616 or EEE614 3

Candidate should choose any of the two, EEE 634, EEE635or EEE 637 6

EEE 602 Seminar 3

EEE 651 M. Eng. Project Report 6

 **Total 18**

 **Total Required 30**

**Elective Course**

EEE 632 Optimal Control Theory 3

EEE 633 Introduction to Stochastic Control 3

EEE 634 Discrete Time Control Systems 3

EEE 635 Non-Linear and Time Varying Control Systems 3

EEE 636 Real Time Computer Control 3

EEE 637 Special Topics in Control System Design 3

**AUTOMATIC CONTROL SYSTEMS– Ph. D**

**First Semester Credit Units**

PGC701 Synopsis and Research Grant Writing 3

EEE 701 Special Topics in Static A.C Machine Control 3

 **Total 6**

**Second Semester**

EEE 737 Special Topics in Control System Design 3

EEE 736 Advanced Real Time Computer Control 3

EEE 703 Seminar I (Proposal) 3

EEE 704 Seminar II 3

EEE 751 Ph.D Thesis 12 **Total 24**

 **Total Required 30**

**MASTER’S COURSE DESCRIPTION IN AUTOMATIC CONTROL SYSTEMS**

**EEE 601 – Advanced Methods of Analysis in Electrical Engineering**

Review of Matrices.Time domain and transfer techniques for linear continuous and discrete-timesystems.State variable methods.State transition matrix for time- invariant and time-varyingcontinuous and discrete systems.Adjoint Systems.Singularityfunctions and superpositionintegrals for linear systems.Fourier,Laplace, Z-transform and generalized transform techniques.Introduction to controllability,observability, and stability.Distributed parameter system analysis. Transfer function, integralequation representation, and state model for selected control systems. Selected numericalanalysis methods and applications **—3 Credit Units**

**PGC 601: Research Methodology and ICTIn Engineering**

Use of advanced analytical tools like MATLAB/SIMULINK, SCILAB/XCOS, etc. for solution of engineering problems and their applications *(Application of these soft wares depends on the various problems formulated in different departments).*Information literacy, information sources (media, publishers, agreggators); validity of information, plagiarism and legal aspects.

Information search – search engines, journal repositories, academic (social) networks, search strategies, personal contacts, tools for managing references.

Integrating information literacy in research, cloud computing, audiovisual tools, e.g powerpoint presentations.

Literature review: Reading and summarizing relevant articles, critical analysis and evaluation of research, identification of themes and comparators, writing review documents and identification of research (or knowledge) gaps.

Scientific method and nature of evidence: Experimental methods and design methods *(as may be applicable to individual departments and research areas)*, data collection and management of quantitative data. Human participants – expert reviews, focus groups, questionnaires and interviews.

Project management and report writing: project planning, report structure and style, general report writing techniques. **– 3 Credit Units**

**EEE 602 Seminar**

A written presentation of modeling, Simulation and Laboratory validations of the candidate’s topic modelling which is baed on candiadte’s area of specialization  **- 3 Credit Units**

**EEE 611 – Theory & Modeling of Electrical Machines**

Equivalent circuits of complex magnetic systems, transformer frequency-dependent equivalentcircuits, inrush currents, DQ representation of AC. Machines (induction machines, synchronousmachines, reluctance machines etc.)AC machine dynamics using dq models. Special characteristic features of dc and ac machines. **–3 credits Units**

**EEE 614 – Electric Drives**

Rectifier-fed DC motors. Chopper-fed DC motors. Design and applications of DC drives.Classification, analysis and control of AC drives.Design and applications of AC drives.Microprocessors in industrial drives. **- 3 credit units.**

**EEE 616 – Logic Control Circuits in Power Engineering**

Digital logic families, linear integrated circuit components, small signal discrete components andtheir main specifications. Common transducers, Microprocessor programmed logic. Design offiring/gating logic circuits for controlled rectifiers, inverters, choppers and cyclo-converters.Design of voltage, current, power and frequency regulation circuits for motor drives and powersupplies. Microprocessor-based logic control methods **– 3 Credit Units**

**EEE 613 Electro-Heating Processes**

Resistance heating.Three-phase and two-phase electrode arc furnaces.Types of inductionheating furnaces. Frequency selection in induction heating power supplies: mains frequency,mains frequency triplers, motor generator sets and variable frequency inverters andcyclo-inverters. **– 3 Credit Units.**

**EEE 631 – Advanced Theory of Control System.**

Review of the techniques of obtaining the time response of linear systems, Nyquist and Routh-Hurwits stability criteria, Bode diagrams, Analysis of piecewise linear system and second ordernon-linear system, method of Isoclines, describing functions and Tsypkin locus, generalization oflyapunov function by lurie and variable gradient techniques; Popov criteria. **- 3 Credit Units.**

**EEE 632 – Optimal Control Theory**

Formulation of optimal control problems, performance indices, necessary conditions foroptimum control of continuous system, principles of optimality, Calculus of variation, Hamilton-Jacobi theory Fontryagin’s maximum principle and dynamic programming. Time-optimal controlproblems, Optimal control of linear plants — the optimal regulation problems with bounded statevariables and bounded controller, singular control problems. Computational techniques **- 3 Credit Units.**

**EEE 633 – Introduction to Stochastic Control**

Stochastic processes – probability theory and random processes. Introduction to the designproblem for systems perturbed by random inputs.Minimization of the mean square error,Estimation of system parameters in the presence of noise. Stochastic differential equations,Gaussinn, Markov, and Veiner-Levy processed. The matched filter.Introduction to adaptivecontrol. **- 3 Credit Uours.**

**EEE 634 – Discrete Time Control Systems**

Classical analysis and design of sampled data control system; Z-transform, sampling ofcontinuous time functions, data system. State variable formulation of linear and non-lineardiscrete time systems.Stability of discrete time systems, Application of Lyapunov’s secondmethod.Optimal control of discrete systems, Discrete time maximum principle; sensitivity.Computer solutions.  **- 3 Credit Units.**

**EEE635 – Theory of Non-Linear and Time Varying Systems**

Analysis of periodic linear time-varying systems - Floquet Theory.Analysis of non-linearconservative systems .Lyapunov stability theorems.The Aizerman problem.Frequency domainstability criteria. Popov’s criteria, sustained oscillation; graphical methods by Lienard andVander-Pol; limit cycles. Optimization of non-linear systems.Controllability and observability.Synthesis of sub-optimal controllers by means of Lyapunov’s functions**. -3 Credit Units**.

**EEE 636 – Real Time Computer Control**

Architectural features of the micro-processor. Assembly language and addressingmodes. Interface techniques. Difference equations.Programmed filters, compensators and controllers.Classical and space computer control. Techniques for improving system responsespeed.

 **-3 Credit Units.**

**EEE 637 – Special Topics in Control System Design**

Transducer Types, characteristics and applications, position, speed; flow rate pressure, andtemperature control methods and applications. Computer aided optimization techniques for thetransient response of classical and modem feedback control techniques**. - 3 Credit Units.**

**Ph.D COURSE DESCRIPTION IN AUTOMATIC CONTROL SYSTEMS**

**PGC 701: Research Grant Technical/Synopsis Writing**

Choice of broad research area with considerations of interdisciplinary topics, Identification of research/ knowledge gaps and research objectives.

Role of technical reports in engineering projects. Fundamental principles of technical writing.Format of different types of reports, outlines, purpose and scope, technical discussion details, role of appendix, function of figures, equation editors, tables and illustration.Literature search, references (citing’s and listings).Nature of recommendations and conclusions.Guides for writing memoranda, business letters.Oral presentation of technical reports and thesis. Synopsis writing

Developing long-term research plan, Identification of potential funding agencies and their requirements.Research objectives in relation to interests of the funding agencies.Estimating research timelines, Budget preparation, manpower requirements and availability, research facilities, legal issues, etc. **-3 Credit Units**

**EEE 701 Special Topics in Static A.C Machine Control**

Direct and Indirect torque and speed control, Field orientation in induction and synchronous motor drives, Sensor-less motor drive techniques, Permanent and brushless DC motor drive techniques. **– 3 Credit Units**

**EEE 736 – Real Time Computer Control**

Architectural features of the microprocessor. Assembly language and addressing modes. Interface techniques. Difference equations.Programmed filters, compensators and controllers.Classical and space computer control. Techniques for improving system response speed. **-3 Credit Units.**

**EEE 737 – Special Topics in Control System Design**

Transducer Types, characteristics and applications, position, speed; flow rate pressure, and temperature control methods and applications. Computer aided optimization techniques for the transient response of classical and modem feedback control techniques**. - 3 Credit Units.**

**EEE751 Thesis**

Each candidate for a Doctoral degree shall be assigned a suitable research project approved by the Departmental Postgraduate Studies Committee. The research topic should be ground breaking, thought provoking and must contribute veritably to existing frontiers of knowledge in the area of candidates choice. The results of the research shall be embodied in the thesis. -**12 Credits Units**

**EEE703 Seminar I – Proposal**

It is expected that each doctoral candidate shall present at least first three chapters of the thesis in a proposal detailing the problem of syudt, the study background, main aim, objectives, literature review, and the methodology to be adopted for the study. In applicable cases, a very clear model of the system or sitiiation to be studied is presented. **-** **3 Credit Units**

**EEE704:Seminar 2 – Research Findings**

A second seminar detailing the results obtained (research findings) from EEE 703 and maing useful contributions and valued added to the existing knowledge is presented here. The entire complete thesis would have been submitted to the department for reading in which all grey areas should be cleared. Candidate will then write a synopsis and proceed for oral examinations by the external examiner.