

**CURRICULUM
OF
ELECTRICAL ENGINEERING
FOR
B.E./B.Sc.**



(Revised 2003)

**HIGHER EDUCATION COMMISSION
H-9, ISLAMABAD**

CURRICULUM DIVISION

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*Composed by **Ghafoor Ahmad**, HEC, Regional Centre, Lahore*

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PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum of a subject, one can judge the state of intellectual development and the state of progress of a nation. The world has turned into a global village, new ideas and information are pouring in a constant stream. It is, therefore, imperative to update our curricula by introducing the recent developments in the relevant fields of knowledge.

In exercise of the powers conferred by Sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide Notification No.D773/76-JEA (Cur.), dated December 4, 1976, appointed Higher Education Commission as the Competent Authority to look after the Curriculum Revision Work beyond Class XII at Bachelor level and onwards to all Degrees, Certificates and Diplomas awarded by Degree Colleges, Universities and other Institutions of higher education.

In pursuance of the above decisions and directives, the Commission is continually performing curriculum revision in collaboration with the Universities. According to the decision of the 44th Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various Committees are constituted at the national level comprising senior teachers nominated by the Universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these Committees.

The National Curriculum Revision Committee on Electrical Engineering in its meeting held in June 10-12, 2003 at the Higher Education Commission, Regional Centre, Lahore finalized the draft curriculum of Electrical Engineering for B.E./B.Sc after due consideration of the comments and suggestions received from the Universities and Colleges where the subject under consideration is taught.

The Final draft prepared by the Curriculum Revision Committee duly approved by competent authority is being circulated for implementation by the Universities.

(PROF. DR. ALTAF ALI G. SHAIKH)
DIRECTOR GENERAL (CURRICULUM)

June, 2003

INTRODUCTION

The final meeting of National Curriculum Revision Committee in Electrical Engineering was held from 10-12 June, 2003 to finalize the draft curriculum of B.E/B.Sc. Electrical Engineering updated in the first meeting held from 17-19th September, 2002 at the Higher Education Commission, Regional Centre, Lahore. The Following attended the meeting:

1. Prof. Dr. Talat Altaf
Chairman,
Department of Electrical Engineering,
NED University of Engg. & Tech., Karachi. Convener
2. Prof. Abdul Qadir Chang
Deptt. of Electrical Engineering,
Mehran University of Engg. & Tech., Jamshoro. Member
3. Prof. Mueenuddin Memon,
Deptt. of Electrical Engineering,
Quaid-e-Awam University of Engg. Sciences & Tech.
Nawabshah. Member
4. Engr. Muhammad Masihuddin
Nominee of Pakistan Engg. Council,
Islamabad. Member
5. Mr. Khalid Akbar,
Director,
National Engg. & Scientific Commission
P.O. Box No.2801, Islamabad. Member
6. Capt. @ M. Haroon Khan
Director (TS)
Human Resources Dev. Department
Pakistan Steel, P.O. Box No.5429,
Bin Qasim, Karachi Member
7. Dr. Tahir Izhar
Deptt. of Electrical Engineering,
University of Engg. & Tech.,Lahore. Member

8. Engr. Akhtar Ali Member
G.M. Electrical
Pakistan Ordnance Factories,
Wah Cantt.
9. Engr. Faizullah Mahar Member/Secretary
Chairman,
Deptt. of Electrical Engineering & comp. Sc./IT
Balochistan University of Engg. & Tech.Khuzdar.

The meeting started with the recitation from the Holy Quran.

Mr. Muhammad Riaz Cheema, Director HEC, Regional Centre welcomed the participants of the meeting on behalf of Chairman HEC. Muhammad Tahir Ali Shah Assistant Director (S&T) Curriculum Wing, HEC Islamabad briefed the participants about the obligations of the Commission to review, revise and develop curricula as per provisions of the Act of parliament, 1976. The committee before taking up the regular agenda unanimously agreed to maintain Prof. Dr. Talat Altaf as its Convenor and Engr. Faizullah Mahar as Secretary.

The committee deliberated upon the comments of the Board of Studies of different Universities and the opinion of the members in the light of the existing curriculum of the universities, and that proposed by Commission in 1999. It analyzed that the suggestions given by academicians for improvement of curriculum, Pakistan Engineering Council and representative of Higher Education Commission have agreed upon the following objectives and final recommendations for Bachelor's degree programme in Electrical Engineering.

OBJECTIVE

1. The curriculum, being proposed for the award of B.E./B.Sc. degree in Electrical engineering, has been planned to meet the following objectives.

It is envisaged that the graduating students shall:

- a. Meet the requirements of the local industry.
 - b. Have the academic background to pursue postgraduate studies at the international level.
 - c. Have design and development training coupled with management and economic background to launch in the market as an entrepreneur.
-
2. The goal of the Electrical Engineering undergraduate program should be to prepare the graduates for entry-level positions as electrical engineers for the broad range of opportunities available in industrial, commercial, and governmental organizations, and to prepare the graduates for continued learning experiences either in a formal graduate program or in continuing education applications. This goal can be achieved through a curriculum designed to accomplish the following five objectives:
 - a) The graduates should be technically competent.
 - b) To maintain a modern curriculum that adapts to changes in technology and society.
 - c) To foster a diverse student population entering and successfully graduating and the graduates will function well in a diverse work force.
 - d) The graduates to be self-motivated, creative people who can succeed in environments where technical innovation is important.
 - e) The curriculum in Electrical Engineering builds upon the base provided by the engineering core subjects.

3. Beyond the engineering core subjects, the curriculum should include a number of required electrical engineering and technical elective courses. Successful completion of the curriculum leaves the student prepared to embark on a career in electrical engineering or to pursue advanced education in postgraduate institutes.
4. The objective of the undergraduate and graduate program should be to educate students in science and engineering so that they can conceive and solve technological problems in society. Social and humanistic issues should also be emphasized in the general education component of the program to provide breadth in education. The students therefore, be prepared for practice, engineering design and hands-on experience throughout the curriculum and supported by diverse laboratory and field facilities to implement design ideas.
5. Opportunities to enhance teamwork, written and oral communication, and self-learning skills should also be available across the curriculum. Students may be encouraged to promote the profession and develop leadership skills through involvement in honorary and professional societies, and participation in laboratory and design project activities. The faculty should have a strong student counseling program, which will facilitate individual contact with students to help them make sound academic decisions and understand the purpose of their education and the profession.
6. The Electrical Engineering curriculum may also include declarations of four interconnected commitments: to students, to faculty, to alumni, and to the State, with the understanding that the latter two include industry. The Educational Objectives of the Engineering Institutions should be based on the mission of the Institution and the perceived needs of the constituents, consistent with Engineering Criteria of the Higher Education Commission (HEC). The mission statement therefore, should be:
 - i. **Depth.** To provide students with understanding of the fundamental knowledge prerequisite for the practice of, or for advanced study in, electrical engineering, including its scientific principles, rigorous analysis, and creative design.

- ii. **Breadth.** To provide students with the broad education, including knowledge of important current issues in engineering with emphasis on electrical engineering, necessary for productive careers in the public or private sectors, or for the pursuit of postgraduate education in electrical engineering.
- iii. **Professionalism.** To develop skills for clear communication and responsible teamwork, and to inculcate professional attitudes and ethics, so that students are prepared for the complex modern work environment and for lifelong learning.
- iv. **Learning Environment.** To provide an environment that enables students to pursue their academic goals in an innovative program that is rigorous and challenging, open and supportive.

LIST OF COURSES

Core Courses

1. Humanities

- a. Pakistan Studies
- b. Islamic Studies or Ethics (for non-muslim students)
(As prescribed)
- c. Engineering Economics & Management
- d. Communication Skills

2. General Sciences

- a. Mathematics (Three Courses)
 - i. Applied calculus
 - ii. Linear Algebra and Solid Geometry
 - iii. Complex variables and transforms
- b. Probability and Stochastic Process
- c. Numerical Analysis

3. Engineering Science

- a. Electrical Workshop
- b. Basic Mechanical Engineering
- c. Basic Civil Engineering
- d. Applied Thermodynamics
- e. Computer Aided Drawing

4. Core Courses of Electrical Engineering

- a. Introduction to Computing
- b. Logic Design and Switching Theory
- c. Basic Electrical Engineering
- d. Network Analysis
- e. Microprocessor Based Systems
- f. D.C. Machines and Drives
- g. A.C. Machines and Drives
- h. Digital Signal Processing
- i. Control Systems
- j. Electronic Devices and Circuits
- k. Integrated Circuits and Systems
- l. Electromagnetic Field Theory

- m. Communication Systems
- n. Power System Analysis
- o. Power Electronics
- p. Instrumentation and Measurements
- q. Electrical Materials and Devices

5. Elective Courses of Electrical Engineering

Power Systems Engineering

- a. Power Economics and Management
- b. Power Transmission
- c. Power Generation
- d. Power Distribution and Utilization
- e. Energy Conservation
- f. Electrical Machine Design and Equipment Training
- g. Power System Protection
- h. Power System Operation and Control

Electronics Engineering

- a. VLSI Design
- b. Industrial Process Control
- c. Filter Theory and Design
- d. Digital Electronics
- e. Computer Control System

Telecommunication Engineering

- a. Microwave Engineering
- b. Optical Fiber Communications
- c. Radar and Navigation Systems
- d. Mobile Communication
- e. Satellite Communication
- f. Digital Image Processing
- g. Communication Management
- h. Digital Signal Processing.
- i. Wave Propagation and Antennas

Computer Engineering

- a. Computer Communication Networking
- b. Computer Graphics
- c. Digital Instrumentation

- d. Digital System Design
- e. Artificial Intelligence and Neural Networks
- f. Micro-controller Based Design
- g. Parallel Processing

Biomedical Engineering

- a. Biomedical Instrumentation
- b. Fields, Forces and Flows in Physiology
- c. Bio-electric Signals: Analysis and Interpretation
- d. Diagnostic Imaging Systems
- e. Biomedical Fluid Mechanics
- f. Biomaterials

SCHEME OF STUDIES
FOR
B.E/B.Sc. ELECTRICAL ENGINEERING

1ST Year

Ist Term/Semester	Credit Hours
1. EE-111 Basic Electrical Engineering	3+1
2. EE-112 Electrical Workshop	0+2
3. GS-113 Applied Calculus	3+0
4. HS-114 Communication Skills	3+1
5. HS-115 Islamic Studies	2+0
7. HS-116 Ethics	2+0
8. ME-117 Basic Mechanical Engineering	<u>3+1</u>
Total:	19

2 nd Term/Semester	Credit Hours
1. CS-121 Introduction to Computing	3+1
2. EE-122 Electrical Materials & Devices	3+1
3. CE-123 Basic Civil Engineering	3+1
4. GS-124 Linear Algebra Differential Equations & Solid Geometry	3+0
5. EE-125 Computer Aided Drawing	0+2
6. HS-126 Pakistan Studies	<u>2+0</u>
Total:	19

2nd Year

3 rd Term/Semester	Credit Hours
1. EE-211 Network Analysis	3+1
2. EE-212 Electromagnetic Field Theory	3+0
3. ME-213 Applied Thermodynamics	3+1
4. EE-214 DC Machines and Drives	3+1
5. GS-215 Complex Variable and Transforms	<u>3+0</u>
Total:	19

4 th Term/Semester	Credit Hours
1. EE-221 Instrumentation and Measurements	3+1
2. EE-222 Electronic Devices & Circuits	3+1
3. CS-223 Logic Design & Switching Theory	3+1
4. GS-224 Probability and Stochastic Process	3+0
5. GS-225 Engineering Economics and Management	<u>2+0</u>
Total:	17

3rd Year

5 th Term/Semester		Credit Hours
1.	EE-311 AC Machines and Drives	3+1
2.	EE-312 Power System Analysis	3+1
3.	EL-313 Integrated Circuits and systems	3+1
4.	xx-xxx (Elective-1)	3+1
5.	GS-314 Numerical Analysis	<u>3+0</u>
	Total:	19

6 th Term/Semester		
1.	EE-321 Power Electronics	3+1
2.	EE-322 Communication system	3+1
3.	EE-323 Control systems	3+1
4.	xx-xxx (Elective-2)	3+1
5.	xx-xxx (Elective-3)	<u>3+0</u>
	Total:	19

Final Year

7 th Term/Semester		
1.	CS-411 Microprocessor Based Systems	3+1
2.	xx-xxx (Elective-4)	3+1
3.	xx-xxx (Elective-5)	3+1
4.	xx-xxx (Elective-6)	3+1
5.	xx-xxx (Elective-7)	<u>3+0</u>
		19

8 th Term/Semester		
1.	xx-xxx (Elective-8)	3+1
2.	xx-xxx (Elective-9)	3+1
3.	xx-xxx (Elective-10)	3+1
4.	EE-422 Electrical Engineering Project	<u>0+4</u>
		16

Note-1: the numbering of the courses is just a guideline. The universities can adopt their own numbering system. The first to the letters of the proposed course number indicates the department, first letter represents

year, second digit represents the term and third number is for the course number

Course codes

CS- Computer System Engineering
EE- Electrical Engineering
EL-Electronics Engineering
HS-Human Sciences
GS- General Sciences
BM- Biomedical Engineering
ME-Mechanical Engineering
CE-Civil Engineering
TC- Telecommunication Engineering

Note. 2: Universities may have total credit hours between 140 to 150 for four year B.E./B.Sc. (Electrical Engineering).

DETAIL OF CORE COURSES
FOR
B.E/B.Sc. ELECTRICAL ENGINEERING

1. HUMANITIES

HS-126 Pakistan Studies

Land of Pakistan: Land and people-strategic importance, natural resources. A brief historical background of creation of Pakistan, government and politics in Pakistan, languages and cultures of Pakistan.

HS-115 Islamic studies or ethics (for non-Muslim students)

Fundamental of Islam, Tauheed: Arguments for the oneness of God, impact of Tauheed on human life, Place of man in the universe, purpose of creation, textual study of Surah al-Rehman and Surah al-Furqan, Prophethood, need for prophet, characteristics of a prophet, finality of prophethood, seerat; life of the prophet as embodiment of Islamic ideology, faith in the hereafter aakhirat, effects of the belief on worldly life.

Ibadah: Concept of Ibadah, major Ibadah, Salat, Saom, Zakat, Hajj and Jihad.

The Holy Quran: Its revelation and compilation, The authenticity of the text,

Hadith: Its need, authenticity and importance. Consensus (*Ijma*), analogy (*Qiyas*).

Sources of Knowledge: Islamic approach to institution, Reason and experience. Revelation Wahi as a source of knowledge.

Moral and Social Philosophy of Islam: The concept of good and evil, Akhlaq-e-Hasna with special reference to surah Al-Hujrat, Professional Ethics Kasb-e-Halal.

Islamic Political Principles: Salient features of the Islamic state, Madina character, Responsibilities of the Head of the state, Rights and Duties of Citizens.

Economics Order of Islam: Right to property, System of Taxation, Distribution of Wealth Zakat and Ushar, Interest Free Economy Shirakat and Muzarabat.

Islam as Living Force: Application of Islam Teaching to Socio-Economic Development in the 20th Century.

HS-116 Ethics (for non-muslim students)

Nature, Scope and methods of Ethics, Ethic and Religion, Ethical teaching of world religious. Basic moral concepts, Rights and wrongs, Good and Evil,

An outline of Ethical systems in philosophy, Heonism, Utilitarianism, Rationalism and Kant. Self Realization Theories, Intuitionism, Islamic moral theory: Ethics of Quran and its philosophical basis. Ethical precepts from Quran and Hadith and promotion of moral values in society.

HS-225 Engineering Economics & Management

Introduction to Economics: Accounting, Cost benefit ratios, Interpretation of financial statements. Fundamental economic concepts. Supply and demands. Types of market and forecasting.

The Basic Concepts of Management: Process of planning. Project Planning. Financial Management. PERT, CPM. Managerial decision making and its impact on society: with emphasis on the selection of corporate goals, measures of corporate performance and concepts of industrial regulations and legal aspects.

Suggested Text: Arranged by the Faculty

HS-114 Communication Skills

Technical report writing and the study of English to enable the student to express his ideas verbally and in writing. Presentation Skills.

Business English: Writing formal and business letters, writing formal memos, drafting notice and minutes of meetings, drafting tender notice, theoretical knowledge and comprehension of contracts and agreements, preparing proposals and technical reports, conducting and writing a project report on a mini research (sessional work).

Engineering Ethics: Introduction, business laws, code of conduct.

Suggested Text: Arranged by the Faculty

2. GENERAL SCIENCES

GS-113 Applied Calculus

Introduction to Functions: Mathematical and physical meaning of functions, graphs of various functions. Hyperbolic functions.

Introduction to Limits: Theorems of limits and their applications to functions. Some useful limits, right hand and left hand limits, Continuous and discontinuous functions and their applications.

Derivatives: Introduction to derivatives. Geometrical and physical meaning of derivatives. Partial derivatives and their geometrical significance. Application problems (rate of change, marginal analysis)

Higher derivatives: Leibnitz theorem, Rolles theorem, Mean value theorem. Taylor's and Maclaurin's series.

Evaluation of Limits using L'Hospital's rule: Indeterminate forms $(0/0)$, (∞/∞) , $(\infty - \infty)$, $(\infty \cdot 0)$, $(0 \cdot \infty)$.

Applications of derivatives: Asymptotes, tangents and normals, curvature and radius of curvature, maxima and minima of a function of a single variable (applied problems) differentials with applications.

Applications of Partial Derivatives: Euler's theorem, total differentials, maxima and minima of two variables.

Integral calculus: Methods of integration by substitutions and by parts. Integration of rational and irrational algebraic functions. Definite integrals, improper integrals, Gamma and Beta functions, reduction formulae.

Applications of integral calculus: Cost function from marginal cost, rocket flights, area under curve.

Vector algebra: Introduction to vectors, Scalar and vector product of three and four vectors. Volume of parallelepiped and tetrahedron.

Vector calculus: Vector differentiation, vector integration and their applications. Operator, gradient, divergence and curl with their applications.

Suggested Text:

Brief Calculus and its applications by Doniel D. Benice.

Applied Calculus by Raymond A. Barnett.

Calculus by Gerald L. Bradley

Calculus and Analytical Geometry by Dr. S. M. Yusuf.

GS-124 Liner Algebra, Differential equations and Solid Geometry

Introduction to matrices, elementary row operations and vector spaces: Brief introduction to matrices. Symmetric and Hermitian matrices, Introduction to elementary row operations, Echelon form and reduced echelon form. Rank of a matrix. Inverse of a matrix by using elementary row operations. Vector spaces. Vector subspaces. Linear combination, Linear dependence and basis, linear transformation.

System of Linear equations: System of non-homogeneous and homogeneous linear equations, Gaussian elimination method, Gauss Jordan method, Consistency criterion for solution of homogeneous and non-homogeneous system of linear equations. Applications of system of linear equations.

Determinants: Introduction to determinants, Properties of determinants of order n , Axiomatic definition of a determinant. Applications of determinants (Cramer's Rule).

Analytic Geometry of 3-dimensions: Introduction Coordinates of a point dividing a line segment in a given ratio. Vector form of a straight line, parametric equations of a straight line, equation of a straight line in symmetric form, direction ratios and direction cosines, angle between two straight lines, distance of a point from a line, Planes: Equation of a plane, angle between two planes, intersection of two planes, a plane and a straight line, skew lines, Cylindrical and spherical coordinate: Introduction to cylindrical and spherical **Coordinates, Surfaces:** Quadratic surfaces, degenerate surfaces, symmetry, traces, intercepts of the surfaces, surface of revolution, Cylinder and cone: Cylinder, directrix of cylinder, right cylinder, The cone, Sphere: General equation of sphere, great circle.

Multiple integrals: Definition, double integral as volume, evaluation of double integral, change of order of integration, Application of double integrals, area, mass of an element, moment of inertia, and center of gravity. Triple integrals, evaluation of triple integrals, application of triple integrals, volume, mass of an element, center of gravity, moment of inertia by triple integrals, triple integration in cylindrical and spherical coordinates.

Differential equations of first order: Differential equations and their classification, formation of differential equations, solution of differential equations, initial and boundary conditions, Methods of solution of differential equation of first order and first-degree: Separable equations, homogeneous equations, equations reducible to homogeneous, exact differential equations, integrating factor, linear equations, Bernoulli equations, orthogonal trajectories in Cartesian and polar coordinates, applications of first order differential equations. Non linear first order differential equations. Non linear first order differential equations: Equations solvable for p, for y and for x, Clairauts equations.

Higher Order Linear Differential Equations: Homogeneous linear equations of order n with constant coefficients, auxiliary/ characteristics equations. Solution of higher order differential equation according to the roots of auxiliary equation. (Real and distinct, Real and repeated, and Complex). Non-homogeneous linear equations. Working rules for finding particular integral. Cauchy Euler equation. Method of variation of parameters for solving $y'' + p(x)y' + q(x)y = f(x)$. Applications of higher order linear differential equations.

Suggested Text:

Brief Calculus and its Applications by Doniel D. Benice.

Applied Calculus by Raymond A. Barnett.

Calculus and Analytical Geometry by Dr. S. M. Yusuf

GS-215 Complex Variables and Transforms

Complex numbers system and complex variable theory: Introduction to complex number systems, Argand's diagram, modulus and argument of a complex number, polar form of a complex number. DeMoivre's theorem and its applications, Complex functions, analytical functions, harmonic and conjugate, harmonic functions, cauchy-Rehmun equations (in Cartesian and polar coordinates). Line integrals, Green's theorem, Cauchy's theorem, Cauchy's integral formula, singularities, poles, residues and contour integration and applications.

Laplace Transforms: Definition, Laplace transform of elementary functions, Properties of Laplace transform, Laplace transform of derivatives and integrals. Multiplication by t and division by t properties. Periodic functions and their Laplace transforms. Inverse Laplace transform and its properties. Convolution theorem, inverse Laplace transform by integral and partial fraction methods, Heavisides expansion formula. Solution of ordinary differential equations by Laplace transform. Applications of Laplace transformation in various fields of engineering.

Series solution of differential equations: Introduction, The solution of $p_0(x)y'' + p_1(x)y' + p_2(x)y = 0$, when $p_0(0) \neq 0$. Validity of series solution, Ordinary point, singular point, Forbenius method, indicial equation, Bessel's differential equation, its solution of first kind and its recurrence formulae, Legendre differential equation and its solution, Rodrigues formula.

Fourier Transform: Definition, Fourier transform of simple function, magnitude and phase spectra, Fourier transform theorems, Inverse Fourier transform, Solution of differential equations using Fourier transform.

Suggested Text:

Advanced Engineering Mathematics by H.K. Dass
Advanced Engineering Mathematics by Dr. B.S. Grawall
Advanced Engineering Mathematics by Erwin Crayzig
Laplace Transform by Schaum Series

GS-224 Probability and Stochastic Process

Set theory: Basic concepts of probability. Conditional probability, Independent events, Baye's formula, discrete and continuous random variables, distributions and density functions, probability distributions (Binomial, Poisson, Hyper geometric, Normal, Uniform and Exponential). Mean, variance, standard deviations, moments and moment generating

functions. Linear regression and curve fitting. Limits theorems, stochastic processes, First and second order characteristics, applications.

Suggested Text:

Erwin Kreyszig, *Advanced Engineering Mathematics*, 7th ed., John Wiley, 1994.

GS-314 Numerical Analysis

Floating Point number system. Error analysis. Solutions of equations. Interpolation. Splines. Numerical differentiation and integration. Numerical methods in linear algebra, system of linear equations, method of least squares, eigen values, eigenvectors. Solution of ordinary and partial differential equations. This subject is to be supplemented with extensive computer exercises.

Suggested Text:

Erwin Kreyszig, *Advanced Engineering Mathematics*, 7th ed., John Wiley, 1994

3. ENGINEERING SCIENCE

EE-112 Electrical Workshop

Safety Precautions: The use and care of tools and measuring instruments. Electric shock and its treatment, use of megger, wire-guage, phase tester and other electrician's tools, Cables, their sizes, current rating and jointing. Solders and soldering. Main features of domestic installations and appliances, e.g. D.B. system, fluorescent lamps, fans etc. Necessity and methods of earthing, faults and remedies, in wiring circuits. Winding practice of machine coils.

Elementary Machine Shop: Detailed study of center lathe and accessories. Plain and taper turning, simple screw cutting. Cutting tools and their grinding. Introduction of shaper, slotter, planner, pillar and radial drilling machines.

Fitting Shop: The use and care of fitter's tools. Marking out of jobs. Practice in metal filing, sawing, drilling, Die Sinking, tapping and reaming. Introduction and use of power jack saw and arbor press.

Smithy Shop: The use and care of forging tools and blacksmith tools. Open hearth forge, practice in upsetting, drawing out spreading, bending, cutting and punching, hardening and tempering of small cutting tools. Soldering, brazing, electric and gas welding.

Carpentry Shop: The use and care of timber, its defects and preservation methods. Practice in planning and sawing. Different types of wood joints. Study of sawing, planning, turning and turning machines, pattern making.

Foundry & Pattern Shop: Casting and pattern making.

Computer Shop: Windows XP, Office automation and use of internet.

Suggested Text:

W.A. Chapman, *Workshop Technology*, Part 1, Arnold Pub. Latest Edition

ME-117 Basic Mechanical Engineering

Static: Fundamental concepts and principles of mechanics. Important vector quantities. Fundamental units. Moments and couples. Resultants of forces and couples. Laws of equilibrium. Free body diagrams; structures, frames and machines.

Dynamics: Fundamentals of dynamics. Dynamics of particles and rigid body including kinematics and kinetics. Applications of Newton's second law of motion. Analysis of motion in two dimensional and three dimensional spaces. Methods of energy and momentum. Applications of Dynamics to the engineering concepts.

Strength of material, Fluid Mechanics, Pulleys, Chains. Design of Flywheel, Bearings, Mechanical Power Transmission.

Suggested Text:

J. L. Meriam & L. G. Kraige, *Engineering Mechanics Vol. 2 Dynamics*, John & Wiley Sons, 1987.

CE-123 Basic Civil Engineering

Basic surveying, Global positioning system, Map reading, X-Y coordinates, Foundations, Civil Engineering Drawing. Preparing drawing for planes. Elevation cross section of single and multi storeyed buildings such as banglow, school, hospital office, mosque and flates etc. Foundation of electrical poles and rotating machines.

ME-213 Applied Thermodynamics

Basic concepts and definitions, Processes & Cycles, concept of Thermodynamic Property and definition of State; First Law of Thermodynamics, Work & Heat as energies in transition, Interchange-ability of Energy States, Working Fluids and Steady / Unsteady Flow Energy Equations, Perfect and Real Gases; Second Law of Thermodynamics,

Reversible and Irreversible Processes, Entropy & Carnot Efficiency, concept of Available Energy.

Suggested Text:

T. D. Eastop & McConkey, *Applied Thermodynamics for Engineers & Technologists*, Longman, 7th Edn., 1995

EE-125 Computer Aided Drawing

Types of Lines and usage. Dimensioning. Lettering. Orthographic 1st angle projection. Sheet Planning. Orthographic 3rd angle projection. Introduction of Computer Aided Drawing. Isometric Projection. Sectional Drawing and Assembly Drawing. The course consists of scale drawing only. Drawing sheets will be prepared on drawing board and on ACAD.

Electrical circuit drawing, Electrical and Electronics CAD's. Industrial Wiring Drawing.

Suggested Text:

A.C Parkinson, *First Year Engineering Drawing*, Latest ed., E.L.B.S.

T. W. Berghauser and P. L. Scrive, *Illustrated AutoCAD, Release 10*, BPB Publishers, George Amura, *Mastering Autocad 2000*

4. CORE COURSES OF ELECTRICAL ENGINEERING

CS-121 Introduction to Computing

Office Automation Tools: MS Word, MS Excel, Power Point and use of Internet.

Computer programming environments, Algorithm development, Structured and modular computer programming in C. Selection, Loop, Arrays, Pointers, Sequential and direct files, and character and pixel graphics. Introduction to sorting and searching. Applications from Physics, Business, Mathematics and Humanities.

Suggested Text:

R. P. Halpern, *C for Yourself – Learning C Using Experiments*, Oxford University Press, *C Programming Exercises*, First Edition, E&ME College, 1995.

CS-223 Logic Design and Switching Theory

Truth Function: Binary connectives, Evaluation of truth functions, Physical realizations, Sufficient set of connectives, Truth functional calculus as

Boolean Algebra, Duality, Fundamental theorems of Boolean Algebra, Switches and Relays, Logic Circuits, Speed and delays in logic circuits.

Minimization of Boolean Functions: Minterm and Maxterm, Karnaugh map, Simplification of Boolean function, POS and SOP expressions.

Tabular Minimization: Prime implicants. Sequential Networks: Latches, Fundamental mode, Synthesis of sequential networks, Minimization of the number of states, Clocked networks.

Special Realization and Codes: Binary adders, Coding of numbers, Decoders and code conversation, ROMS, NAND and NOR implementation, Parity checkers, Counters, shift Registers and Memories, Encoding and decoding.

EE-111 Basic Electrical Engineering

Electrical Elements and Circuits: Energy and Energy transfer, Electric charge, electric current, potential difference & voltage, Electric power & energy, Electric circuits, sources, resistance, specific resistance temperature coefficient of resistance, Ohm's law, Fundamental circuit laws, Kirchoff's laws, Direct applications of fundamental laws to simple resistive networks, Introduction to node voltage and loop current methods.

Capacitance: permittivity expression for capacitance, Charging and discharging, series and parallel connection of capacitors.

Magnetic Circuits and Transformer: Magnetic effects of electric current, force produced on current carrying conductor placed in magnetic field LHR, electromagnetic induction, magnitude and direction of induced emf, Lenz's law. Magnetic circuit concepts, Magnetization curves, Characteristics of magnetic materials, Magnetic circuits with DC excitation, Induced voltages, Self-inductance, inductance of long solenoid Mutual Inductance. Magnetic circuits with AC excitation, Hysteresis and eddy current losses, Introduction to transformer, The ideal transformer e.m.f equation.

A.C Fundamental: Generation of alternating emf , introduction to periodic functions, RMS or effective, Average and maximum values of current & voltage for sinusoidal signal wave forms. Introduction to phasor representation of alternating current. Power and A.C. circuit, active power, reactive power apparent power and power factor.

EE-211 Network Analysis

Network Theorems: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, star delta transformation for d.c and a.c circuits. Single-phase and three phase circuit analysis.

Two port network: Introduction, characterization of linear time-invariant, two ports by six sets of parameters. Relationship among parameter sets. Inter connection of two ports. Initial condition determination, Laplace Transform and differential equations, Laplace transform of signals involving generalized functions. Convolution. Routh Hurwitz criterion and stability. Poles & zeros. Impedance functions and network theorems. Two port parameters, Frequency response, Magnitude and Phase plots. Fourier series and transform. This course is supplemented with computer simulation of circuits and the study of responses on computers. It is also coupled with a practical laboratory.

Suggested Text:

S. Franco, *Electric Circuits Fundamentals*, Oxford University Press, 1995.
J. S. Kang, *PSPice Manual for Electric Circuits Fundamentals*, Oxford University Press, 1995.

CS-411 Microprocessor Based Systems

Introduction to Microprocessor: Basic concepts, Control unit, Internal registers, ALU, The microprocessor state, An 8-bit microprocessor (8085A or Z-80 or 6800), Timing and sequencing, Power-on and manual RESET. Memory and I/O synchronization: The wait state, Hardware single stepping, Memory speed requirements, Logic levels, Loading and Buffering. The instruction set: Data transfer Logic operations and branching, Programmed I/O interrupts and DMA operations, digital data and display, Analogue data input & output, Microprocessor system design. Program Assembly and testing, Software development, Assembly source programs, Manual Assembly of programs, Assembler directives, Pseudo instructions, Two pass Assemblers, Macros, Software testing.

The Microcontroller: Single-chip microprocessor, an introduction to microcontrollers, the 8051 internal RAM and registers, the 8051 interrupts systems, the 8051 instruction set, other microcontrollers on the 8051 family.

Developing Microprocessor-Based Products: An introduction to the design process, preparing the specification, developing a design, implementing and testing the design, regulatory compliance testing, design tool for microprocessor development.

EE-214 D.C. Machines and Drives

Electromechanical Energy Conversion: Forces and torques in magnetic field systems. Energy balance. Singly excited system. Coenergy. Multiply excited system. Dynamic equations.

D.C. Machines Fundamentals: Simple linear machine. A loop rotating between pole faces. Commutation. Armature construction. Armature reaction. Induced voltage and torque equation. Construction. Power flow and losses.

D.C. Generators: Equivalent circuit Magnetization curve. Separately excited; shunt, series and compounded generators. Parallel operation.

D.C. Motors: Equivalent circuit. Separately excited; Shunt, permanent-magnet, series and compounded motors.

Speed control of DC motors: Starters, speed control methods for series, shunt and compound motors, series parallel control for traction motor, multi-voltage control, plugging, Dynamic braking, testing efficiency and temperature rise, determination of losses, direct and indirect test, estimation of temperature rise of armature, commutator and field winding, Efficiency.

Electromechanics and Machines: Transducers Unified Machine Theory.

Suggested Text:

Electric Machinery Fundamentals 2nd ed. 1991 by Stephen J. Chapman, McGraw-Hill.

Electric Machinery, 5th ed. 1991. Fitzgerald, Kingsley and Umans, McGraw Hill.

Electrical Machines. Hindmarsh, McGraw Hill.

EE-311 A.C. Machines and Drives

Transformers: Transformer Fundamentals, Importance of transformers. Types and construction. Ideal transformer. Theory and operation of real Single-phase transformers phasor diagrams. Leakage reactance. Losses. Equivalent circuit parameters. No load and short circuit test per Unit systems. Voltage regulation and efficiency.

Autotransformers. Tapping. Parallel operation and load division. Inrush current. Exciting current. Three phase transformer. Per unit system. Three phase connections and harmonic Suppression. Vector groups. Three phase transformation using two transformers.

Three Phase Induction Motor: Production of rotating field and torque. Reversal of rotation. Construction. Synchronous speed. Slip and its effect on rotor frequency and voltage. Equivalent circuit. Power and torque. Losses, efficiency and power factor. Torque-speed characteristics. Starting and speed control. Induction generator.

Single-Phase Induction Motors: Types and performance Analysis. Heating and cooling of motors.

Synchronous Generator: Construction. Excitation system. Equivalent circuit. Phasor diagram. Power and torque. Measurement of parameters. Generator operating alone. Capability chart. Synchronization Parallel operation with infinite bus and power sharing. Parallel operation of same size generators generating, Loss of field excitation. Cooling systems. Shut down procedure.

Synchronous Motors: Principle of operation starting, Shaft load, power angle and developed torque. Counter voltage (CEMF) and armature reaction voltage, equivalent circuit and phasor diagram. Power Equation. Effects of changes in shaft load and field excitation. V-curves. Losses and efficiency. Power factor improvement. Speed control. Ratings. Design aspects of transformers, Induction motors and synchronous motors.

Suggested Text:

Electric Machines, 1st Ed. 1991 (chapters 3,4,5,8,9). Charles I. Hubert, Maxwell Macmillan.

Electric machinery Fundamental, 2nd ed. 1991 (chapter:2,8.9 and 10), Stephen J. Chapman, McGraw Hill.

EE-XXX Digital Signal Processing

Applications of DSP. Digital signals, systems and convolution. Fourier transform and frequency response. Sampling. Discrete time Fourier transforms. DFT and FFT algorithms. Z-transform. FIR, IIR filters and their implementation. FIR filter design methods and IIR filter design methods.

Suggested Text:

Digital Signal Processing by J. P. Proakis and D. G. Manolakis.

EE-323 Control Systems

Examples of electrical, mechanical and biological control systems. Open and closed-loop control Mathematical models. Block diagrams. Second order systems. Step and impulse response. Performance criteria. Steady state error. Sensitivity, s-plane system stability. Analysis and design with the root locii method. Frequency domain analysis: Bode plots, Nyquist criterion, gain and phase margins, Nichols charts. The State-space method: state equations, flow graphs, stability. Compensation techniques. Sampled-data systems: z-transform, stability.

Suggested Text:

Linear Control Systems. McGraw-Hill, Katsushiko, Ogata.

EE-222 Electronic Devices and Circuits

P.N. Junction, Diode circuits: choppers, clampers and rectifiers. Zener diode, LED, Laser diode, photo diode, tunnel diode, BJT's FET's and MOS-FET'S, biasing and Amplifier circuits. Operational amplifier fundamentals, Multistage amplifier. Feedback in Amplifiers.

Suggested Text:

Principles of Electronic Devices and Circuits by Malvino.

EE-313 Integrated Circuits and Systems

Differential amplifiers, current source biasing in integrated circuits. Operational amplifiers. Operational amplifier circuits, non-inverting, inverting, integrator, differentiator Schmitt trigger etc. Integrated circuit logic families, LSI, MSI & VLSI. design basics.

Suggested Text:

A. S. Sedra & K. C. Smith , *Microelectronic Circuits*, 4th edition, Oxford University Press, 1997.

EE-XXX Electromagnetic Field Theory

Vector analysis. Static electric field and scalar potential. Dielectric materials. Electric force and energy. Potential problems. Steady currents, magnetic field and vector potential. Magnetic materials and circuits. Magnetic force and torque. Faraday's Laws. Boundary conditions. Maxwell's equations. EM energy conservation. Wave equations and EM waves.

Suggested Text:

M. N. O. Sadiku, *Elements of Electromagnetics*, 2nd edition, Oxford University Press, 1994.

EE-322 Communication Systems

Introduction: Fundamental terms and definitions, information, message, message, signal, analog and digital signals, elements of communication systems, modulating and coding need for modulation, coding methods and benefits.

Signals and spectra: Method of signal representation, time and frequency domain, mathematical representation of signals, Fourier series and Fourier transform, power in a signal, Parseval's power theorem. Rayleigh energy

theorem, properties of Fourier Transform, convolution of signals, specific signal types as impulse step and signum function.

Signal Transmission and filtering: Linear time invariant systems, impulse response and superposition integral, transfer function, block diagram analysis, distortion and equalizers, transmission loss and repeater, ideal and real filters, quadrature filters and Hilbert transform, correlation and spectral density.

Probability and Random variables: Probability functions, probability models and distributions, statistical averages.

Random Signals and Noise: Random process, ensemble and time average, stationary and ergodic process, noise equivalent BW, Analog base band transmission.

Linear Modulation: Band pass systems and signals, AM, DSB, SSB, VSB, modulated signals, modulators, balanced modulator, & switching modulator, SSB generation (method), demodulators, synchronous, detection, heterodyne detection, envelope detection.

Transmission Lines: Fundamentals of Transmission line, characteristics impedance, losses in T/L. Standing waves, quarter and half wave lines, reactance properties of T/L fundamentals of smith chart, double stub, directional couplers, splitters.

Exponential CW Modulation: Frequency and phase modulation, bandwidth criteria, generation methods, receivers, de-emphasis filtering.

Pulse Modulation: Sampling Theory, ideal sampling and reconstruction, aliasing, PAM, PWM, PPM.

Suggested Text:

Communication Systems by Bruce Carlson

Analog and Digital Communication by Simon Haykin

CS-XXX Computer Communication Networking

Telecommunication networks: hardware and software, reference models, transmission media, wireless transmission, the telephone system, narrow and broad-band ISDN, ATM, cellular radio, communication satellites. The data link layer: design issues, error detection and correction, sliding window protocols. The medium access sub-layer: MAC protocols, IEEE 802.3 for LANs and MANs, fast Ethernet, satellite networks. The network layer: routing, congestion control, internetworking, the network layer in the Internet. The transport layer: the transport service, TCP and UDP. The application layer: network security, domain name system, electronic mail, the worldwide web, multimedia.

EE-312 Power System Analysis

The Admittance Model and Network Calculations: Branch and Node admittances; Mutually coupled Branches in Y-bus; Equivalent Admittance Network; Modification of Y-bus; Impedance matrix and Y-bus; the method of successive elimination; Node Elimination (Kron Reduction); Triangular Factorization; The Impedance Model and Network Calculations: The bus, admittance and impedance Matrices; Thevenin's Theorem and Z-bus; Modification of an existing Z-bus; Direct determination of Z-bus; Calculation of Z_{bus} elements from Y_{bus} ; Power Invariant Transformations; Mutually coupled branches in Z_{bus} .

Symmetrical Faults: Transients in RL circuits; internal voltages of loaded machines. Under fault conditions; fault calculations using Z_{bus} ; Equivalent circuits; Selection of circuit breakers.

Symmetrical Components and Sequence Networks: Synthesis of unsymmetrical phasors; symmetrical components of unsymmetrical phasors; symmetrical Y and D circuits; power in terms of symmetrical components; sequence networks of Y and D impedances; sequence networks of a symmetrical Transmission line; sequence Networks of the synchronous Machines; Sequence Networks of Y-D Transformers; unsymmetrical services impedances; sequence networks of Y-D Transformers; unsymmetrical services impedances; sequence networks; positive, negative and zero sequence networks;

Unsymmetrical Faults: Unsymmetrical faults on power systems; single line to ground faults; line to line faults. Double line to ground faults; Demonstration problems; open conductor faults.

Load Flow Studies: Review of network equations and solutions, network model equations and their formulation, load flow problem, Gauss-Siedel iterative method and algorithm for load flow solution, Newton-Raphson method, NR-Algorithm for load flow solution, Decoupled load flow methods, comparison of load flow methods, control of voltage profile. Computer Application.

Steady state and Transient Stability: the swing equation, Application of swing curve & solution of problems using digital computers, stability of loads, effects of mechanical and electrical time lag and delays, Electromechanical behavior of machine/lines/busbar systems equal criterion in machine dynamics.

EE-321 Power Electronics

Principles of Power Electronics, Converters and Applications, Circuit Components and their Effects, Control Aspects.

Power Electronic Devices: Power diode, Power BJT, Power MOSFET IGBT & SCR's, GTO, & TRIAC and DIAC: construction, characteristics, operations, losses, ratings, control and protection of thyristors.

AC to DC converters/rectifiers: Half wave and full wave rectifiers with resistive and inductive loads. Un-controlled, semi controlled and full controlled rectification. 3 Phase rectifiers: un-controlled, semi controlled and full controlled. 6-pulse, 12-pulse and 24 pulse rectification, PWM converters.

DC to AC converters/inverters: Single phase DC to AC converters, 3 Phase inverter, 6-pulse, 12 pulse inverters, PWM inverters.

Switch Mode Power Supplies: DC to DC conversion, Buck converter, Boost converter and Buck-Boost converters. Isolated converters, Forward converters, Flyback converters.

Suggested Text:

Philip T. Krein, Elements of Power Electronics, Oxford University Press, 1997.

EE-221 Instrumentation and Measurements

Measurement and Errors: Definition, Accuracy, precision, sensitivity, resolution, Decibel. Bandwidth. Significant figures. Types of errors. Constructional features. Types of Ammeters, meter, etc.

Electromechanical Instruments: Temperature compensation. Extension of Instrument ranges by shunts and multipliers. Ohms per volt and loading effect for voltmeter. Calibration of D.C. Instruments. Watthour meter. Power-factor meters. Instrument transformers. Frequency meters. KVAR meters. Recording Instruments. Phase sequence measurement.

Bridges and Potentiometers: Wheatstone bridge. Kelvin bridge. A.C. bridges and their applications. A.C and D.C. potentiometers.

Electronic Instruments: Amplified D.C. meters. Average, peak, and true r.m.s responding A.C. voltmeters. Electronic multi-meters. Considerations in choosing an analogue voltmeter. Q meter Dual trace and storage oscilloscopes. Introduction to digital instruments. Phase angle measurement.

Measurement of Non Electrical Quantities: Classification of transducers. Measurement of temperature, pressure, displacement, vibration, speed and acceleration.

Signal Analysis: Wave analysis. Harmonic distortion analysis. Spectrum analysis.

Suggested Text:

Electronic Instrumentation and Measurement Techniques, W.D. Cooper & A.D. Helfricol.
Fundamentals of Electrical Measurements, B.S. Gragory.
Electronic Measurement and Instrumentation, Olivar

EE-122 Electric Materials and Devices

Conductors, semi conductors and insulators, Energy bands, Insulators used in electrical systems. Super conductors, soft magnetic materials, permanent magnet materials.

Semi conductor materials, PN-Junction, Fabrications, epitaxially grown, diffused and ion implanted junction, Depletion approximation, Zener, Varator and tunnel diodes, LED, Laser Diode, Fiber Optics.

Suggested Text:

Electronics by Grobe

5. ELECTIVE COURSES OF ELECTRICAL ENGINEERING

POWER SYSTEM ENGINEERING

EE-XXX Power Economics and Management

Introduction of Economics: History of economic thought. Definition of economics. Macro and Micro economic. Economics laws and applications. Assumptions and methods of economics. Cost benefit analysis. Prices, wages, rent, interest and profit. Economic planning and development.

Load Analysis and Management: Types of loads. Estimation of load. Load growth and load forecasting. Load duration curves. Maximum demand, Diversity and Diversity Factor, Load, Demand and Demand and Demand Factor, Capacity and Utilization factors and their importance in load estimation and analysis. Load management.

Financial Management and Cost Analysis: Cost of power plant. Financial mathematics. Depreciaton and Amortisation. Maintenance and operating costs. Economic selection of number of units in the power station. Relative costs of various power plants. Financial Management.

Tariffs: Energy Tariff objectives. General Tariff forms. Different types of tariffs, their origin and justification. Optimum tariff design. WAPDA tariff system. Private power policy.

Feasibility Studies: Feasibility study of power generation, transmission and distribution, and electrification of Houses, Multi-story building and industries. Project documentation.

Management of Power System: Reliability and optimization. Theory of management. Project management. Management of large power plants. Personnel management information systems.

Procurement, Tendering and Contracts:

Electricity Act 1910 & rules 1937 & contracts. Project planning & preparation of project cycle 1 to 5 (PC-1 to PC-5)

Suggested Text:

M.L.A. Nand. 1986. A Text book of Electrical Power. Vikas Publishing House Pvt. Ltd Delhi.

Endward A. Power System Economics, London.

EE-XXX Electrical Machine Design and Equipment Training

The students will have to submit a hand written report consisting of Class work, Design and Laboratory work for evaluation and viva-voce examination. Theory paper will be from Part-A only).

Part-A: Machine Design: Industrial standardization. National and international standards, codes and testing laboratories. Manufacturing and operating systems, Design considerations for electrical machines, Properties and applications of materials for magnetic machine insulation system and its design considerations, Thermal time constant. Cooling systems of transformers and rotating machines. Duty cycles. Ratings and temperature-rise. Mechanical design considerations.

Specific loading and output equations of power transformer and induction motor. Design of transformer or induction motor. Introduction to computer Aided Design (CAD) and, computer aided manufacturing (CAM).

Part-B: Installation, Maintenance and trouble shooting of machines: Safety precautions, trouble shooting and emergency repairs. Installation, commissioning, testing maintenance, and trouble shooting of (i) Power Transformer and (ii) Induction Motors.

(iii) Ac generators.

Part-C Equipments training (Practical): measurement of magnetic flux , inductance and reluctance of a part of electrical machines study of transformer and rotating machine parts. Understanding operating principles , ratings and application of following equipment. Power supplies, magnetic contactors, thermal overloads, miniatutre circuit breakers, metallic Clad circuit breakers , earth leakage circuit breaker, clip on meters, cable fault

locators, Meger earth tester, Relay testers, Motor controllers, tachometers, phase **tester** (L.V and H.V)

Suggested Text:

Khanna, 1990. Testing Commissioning Operation and Maintenance of Electrical Equipment. 3rd ed., Khanna Publisher, India.

EE-XXX Power Transmission

Percent and per-unit quantities, selection of base and change in base of per unit quantities, Node Equations, one-line diagram.

Systems of Transmission: Choice of voltage and choice of AC/DC systems. Economic comparison of various transmission systems. Standard voltages in Pakistan and abroad for transmission and sub-transmission. Introduction to HV, EHV and UHV system.

Series Impedance of Transmission lines: Conductor types, Resistance, Skin effect, line inductance based and flux considerations. Inductance of single phase and three phase lines. Inductance of composite conductor line. Inductance of Bundled conductors. ***Capacitance of Transmission Lines:*** Capacitance of single phase and 3-phase lines, Effect of earth on capacitance, capacitance of bundled conductors, parallel circuit lines, Ferranti effect.

Representation of Transmission Lines: short, medium and long transmission lines, Solution of equations, traveling waves, surge impedance loading, equivalent circuit, power flow through the line, voltage regulation and line surges.

Mechanical Design of Overhead Lines: Line supports, sag and tension calculation, total length of conductor supports at different levels, mechanical degree of safety, effect of wind pressure and ice loading, conductor Vibration and use of dampers.

Insulators: Insulator material types of insulators, voltage distribution over insulator string, string efficiency, methods of improving the string efficiency. Testing of insulators.

Corona: Corona effect, corona loss, radio interference due to corona.

Underground Cables: Types of cables. Calculation of inductance and capacitance. Insulation resistance. Insulation breakdown of cables. Thermal characteristics of cables. Calculation of current rating of the cables. Fault locating techniques cable jointing techniques.

HVDC Transmission: introduction and classification of HVDC transmission, limitation of AC interconnection and advantages of DC interconnection. Components of HVDC transmission. Converting and inverting station.

Suggested Text:

Elements of Power System by Stevenson, 5th ed.

Power System analysis by Stevenson and Grainger

EE-XXX Power Generation

Thermal Power Plants: Sources of conventional energy and method of harnessing, special features and cycles used in steam, gas and diesel power plants, combine cycle systems and cogeneration. Location of the above plants and selection of units, prime movers and associated equipment.

Hydroelectric Power Plants: The plants and their equipment, layouts, run of the river and accumulation type station, types of hydroelectric turbine and their station.

Nuclear Power Plants: Nuclear reaction, fission and fusion reaction, critical mass chain reaction, moderators, reactor control and cooling, classification of reactors, different types of reactors, radiation damages, shielding of gamma rays neutrons, materials for construction.

Thermoelectric Generators: Thermoelectric effect, solid state description of thermoelectric effect, analysis and design of thermoelectric generator, figure of merit, device configuration, solar and radioisotope powered generators, applications.

MHD Generators: Gaseous conductors, analysis and design of MHD generator, problems associated with MHD generation, possible configuration.

Photovoltaic Generators: Radiation principles, optical effects in semiconductors and p.n-junction, Analysis and design of converter, fabrication of cells, solar cells in space.

Fuel Cells: Thermodynamic principles, efficiency of fuel cell factors limiting the performance, design, new development in fuel cells, possibility of future use in Electric vehicles.

Suggested Text: *Energy Conversion by Arche W. Culp*

EE- XXX Power Distribution & Utilization

Distribution: Introduction to distribution system. Urban. Suburban and Rural distribution systems. Primary, secondary and Tertiary voltages. Radial and Ring Main systems. Application of distribution transformers. Estimation of load. Load characteristics. Substation-Switch gears and bus bar arrangements. Calculation of voltage drop and regulation in distribution feeders.

Grounding and Earthlings: Distribution transformer neutral. Earthing resistance. Earthing practice in L.V.network.

Power Factor: Disadvantages and causes of low power factor, Methods for improvement. Application of shunt capacitors in distribution network.

Batteries & Electrochemical Processes: Main types of batteries and their working, Battery charging, Electroplating, Electrolysis, and Electrometallurgical process, cathodic protection of poles, gas pipes, oil pipes and water structures.

Heating and Welding: Electric heating: Resistance, Induction and Dielectric heating. Electric furnaces, Microwaves heating.

Electric Welding: Resistance welding and its types.

Illumination: Fundamentals of illumination Engineering; laws, units, terms used. Requirements for good lighting. Illumination schemes for various situations (street lighting, Commercial/Industrial lighting, Stadium/flood/Stage/Spot lighting etc.). Types of lamps, their working and relative merit.

Note:-Practical work is based in the above theoretical course.

Suggested Text:

Electrical Power Distribution System by Turan Gonen

A Text Book of Electrical Power by M. L. Anand, 1998.

EE- XXX Power System Protection

Causes of Over Voltages. Propagation of surges. Insulation coordination. Determination of system voltages produced by traveling wave surges. Protection against lightning. Surge arrestors and directors. Interference with Communication circuits. Types, performance and selection of Fuses. Purpose, type, selection and location of Reactors. Static, electromagnetic and electromechanical relays. Microprocessor controlled relays. Short Circuit calculations. Initiation of arc. Recovery voltage and restriking voltage. Classification of circuit breakers. Protection Schemes.

EE- XXX Power System Operation and Control

Introduction to power system control and its importance: Modes of Power system operation. Major tasks of operation.

SCADA (Supervisory control and Data Acquisition): System-Remote terminal unit, Control Centers, Communication Sub System, remote terminal unit, Control centers, Communication aspects.

Economic Dispatch: Characteristics of power generation units. Economic dispatch problems with and without consideration of losses. Incremental

fuel cost, penalty factor, economic power interchange, Static and dynamic analysis of a one-area system. Evaluation of effect of speed change on droop characteristics.

Suggested Text:

Power System Stability and Control by P. Kundur.

Power Generation Operation and Control by Woolen Barg

Power System Control Technology by Trosten Cegral.

ELECTRONICS ENGINEERING

EL-XXX VLSI Design

Presentation of Concepts and techniques used in the fabrication of VLSI circuits. Topics include basic semiconductor and MOSFET theory, Integrated Circuit Fabrication, Integrated Circuit Layout, NMOS and CMOS logic design. Simulation of circuitry. Analogue circuit design, memory and processor design, testing of VLSI system architecture.

Suggested Text:

Electronic Circuits by Schilling and Belove.

Micro Electronic Circuits by Dr. Habibullah Jamal.

EE- XXX Industrial Processes Control

Monitoring and control of volume, flow and temperature. Vibration monitoring and control. Weight, width, thickness control. Automatic gauge control. Combustion/burner management in boilers, furnaces etc.

Pneumatic electronics and PID Controllers, control Valves, advance control techniques, microprocessor based implementation, three level and time delay method of tambura, decentralized control

Suggested text:

Instrumentation for process measurements and control, by Anderson, N.

Computer based industrial control, by kirshankant, prentice hall of India

EE-XXX Computer Control System Design

State variable description of systems, canonical forms, relation to transfer functions, solution of the state equation, Eigen values and eigenvectors. Regulator design using state feedback, controllability. State estimators, observability. Design of servomechanisms with non-zero command inputs. Introduction to optimal regulator design. Non-linear phenomena and their

effect on design. Describing functions, limit cycles. Phase plane analysis, trajectories, linearization of non-linear differential equations, equilibrium points and their classification. Sampled data systems. Discrete signals and sampling, discrete transfer functions. Discrete equivalents for continuous controller. Discrete models for sampled data systems, pulse transfer functions for feedback systems. Direct digital design by transform methods.

EL-XXX Solid State Physics and Devices

Solid state physics. Energy bands, semiconductors and their physics. Doping mechanism and their effects. Devices to include photodiode, LEDs, phototransistor, solar cells, and charge coupled devices.

Suggested Text:

B. G. Streetman, Solid State Electronic Devices, 3rd ed., John Wiley.

EE-XX Filter Theory and Design

Introduction to Filters. Active Devices used in Active Filter Design. Circuit design Approach. Design of first order filters sections in cascade. The bi-quad circuit. Sensitivity analysis. Circuit Design with simulated elements. Switched capacitor filters. Discrete time filters.

Suggested text:

Analog Electronic Circuits (Analysis and Practical) by Northrop

EL-XXX Digital Electronics

Transistor inverter design and analysis. Noise margin. Fan-out. Propagation delay. Switching speed. Detailed design of pulse and switching circuits. Switch. Mono-stable, astable and bi-stable circuits. Emitter coupled flip-flop. Schmitt trigger. Precision timing circuits, Sweep generators. Saturating and non-saturating logic families (DTL, TTL, ECL, I²L, CMOS). Transfer characteristics, Fan out, Speed, Power consumption, Detailed study of timer ICs and their applications, Analogue and digital circuit interface with applications, Oscillators, RC phase shift, Hartley, Colette and Clapp configurations, Introduction to the fabrication of digital microelectronic P-MOS, N-MOS, C-MOS, and Bi-CMOS circuits, Epitaxy, ion implantations and oxidation.

Instrumentation: Principle and operation of different meters. Measurement of electric components values and signals. Bridges. Oscilloscopes. Digital meters, frequency meters. Recorders. Plotters. Digital techniques for

voltage, frequency and time measurements. Any other topics deemed relevant by the faculty.

TELECOMMUNICATION ENGINEERING

TC-XXX Microwave Engineering

Microwave components: waveguides, waveguide junctions, directional couplers, isolators, circulators, resonators. Microwave generators: microwave tubes, two cavity klystron, reflex klystron, TWT, magnetron. Microwave semiconductor devices. Gunn diode, Impact diode, PIN diode, Mixers, Detectors. Microwave measurements, measurement of frequency, VSWR, power, noise and impedance.

Suggested Text:

Kennedy, *Electronic Communication Systems*, 4th edition, McGraw Hill 1992.

TC-XXX Optical Fiber Communications

Optical beams and resonators including ray tracing, Gaussian beam propagation, stable and unstable resonators; classical theory of spontaneous and stimulated emission including a discussion of homogeneous and inhomogeneous line broadening; laser pumping and population inversion in three level and four level systems; fundamentals of laser oscillation, dynamics and threshold; laser cavity equations; laser spiking and mode competition; Q-switching; active and passive mode locking; injection locking; single frequency operation; introduction to fiber lasers and active optical fiber devices. Design Considerations of a Fiber Optics Communication Systems: Analog and Digital Modulator, Noise in Detection Process, BIT Error Rate (BER). System design. Maximum Transmission distance due to attenuation and dispersion.

Suggested text:

Optical Fiber Communications by Cruiser, Gerdkiser
Opto Electronic by Wilson and Hawks
Laser Electronics by Joseph T. Verdeyen.

TC-XXX Radar and Navigation Systems

Principles of Video cameras, Black and White Composite video signal, Colour TV concepts. Television receivers and trouble shooting. Introduction to Radars. Types of Radars. Elements of a Radar System. Noise.

TC-XXX Mobile Communication

Introduction to Wireless Communication System, The cellular concept-system design fundamentals, Mobile radio propagation, Modulation techniques for mobile radio, Multiple Access Techniques for Wireless communication, Wireless Networking, Wireless Systems and standards, AMPs, GSM, Truncking Theory, Wireless Application Protocols (WAP), Wireless Markup Language (WML). Bluetooth-compatible cellular telephone system.

Suggested text:

Wireless Communications by Theodore S. Rappaport.
Wireless Application Programmer's Library by Phil Schmauder
Multiple Access Protocols for Mobile Communication.
Illustrated Telecom Dictionary
Telecom Fact Book by Garbin.

TC-XXX Satellite Communication

Introduction to satellite communication, satellite link design, propagation characteristics of fixed and mobile satellite links, channel modeling, access control schemes, system performance analysis, system design, mobile satellite services, global satellite systems, national satellite systems, mobile satellite network design, digital modem design, speech codec design, error control codec design, low earth orbit communication satellite systems.

Suggested text:

Mobile communication Satellite by Tom Logsdan
Global System for Mobile Communications System, by Joachim Tisat.

CS-XXX Digital Image Processing

Image formation process, types of images (Infrared, Thermal and Video range etc.), image segmentation, Hough transform, shape from stereo, motion and shading. Image acquisition techniques, digitization, acquisition flaws, image storage, compression techniques, image transformation (translation, scaling, rotation, stereo, 3D modeling , discrete time description of signals , fast Fourier transform image enhancement image histogram, contrast enhancement, histogram manipulation , thresh holding, binarization, Grey scale and colour images, smoothing, sharpening, edge detection, morphological operators (erosion, dilation, opening, closing) medical axis transform, skeletonization, thinning.

Suggested Text:

Gonzalez and Wood, *Digital Image Processing*, Addison Wesley, 1993.

TC-XXX Telecommunications Management

Theories of Telecommunications Management: A Concept of Management, Different approaches to the Management, Components of Telecommunications Management. Telecommunications Management Skills. Functions of Telecommunications Management. Roles for Telecommunications Management. Model of Telecommunications Management.

Telecommunications Financial Management: Basic financial Aspects of Telecommunications Management. Tangible assets, Intangible assets, Liabilities, Depreciation and Amortization. Methods of financial reporting. Financial Planning and Projections. Computerized Telecommunication Management. Traffic, Sale, Accounting, Programming.

Personnel management and Employee relations: Functions of Personnel Administration in Telecommunications. Organizational hierarchy. Core departments in Telecommunications. Job description in Telecommunications. Staffing: Recruitment, Training and evaluation policies. Telecommunications Management and labor relations. Guilds and Unions, Union Organization and Operation Management and Collective Bargaining.

Industry and market Structure of Telecommunication: Elements of Market Structure. Elements of Market Conduct. Elements of Market Performance. Acquisition Strategies. Media Valuation. Market Analysis.

Telecommunications Management in Future: Globalization and Vertical Integration, Technological Convergence, Telecommunications Management and Social Change, Successful Management for new Millennium.

Suggested Text:

Telecommunications cost Management by S.C. Strother, Artech House
Telecommunications Management by Barry L. Shurman, McGraw Hill

TC-XXX Digital Signal Processing

Introduction scope, Comparison between continuous time signal and discrete time sequence, Properties of LSI system, Difference equation, Causality, stability. Discrete Fourier transform.

Applications of DSP. Digital signals, systems and convolution. Fourier transform and frequency response. Sampling. Discrete time Fourier

transforms. DFT and FFT algorithms. Z-transform. FIR, IIR filters and their implementation. FIR filter design methods and IIR filter design methods. FFT algorithms, Spectrum analysis, VLSI signal processors.

TC-XXX Wave Propagation and Antennas

Transmission Lines, micro strip transmission lines, transient waves. The wave equation and waveguides. Traveling and standing waves. EM plane waves. EM radiation. Properties of antennas. Measurement of antenna characteristics. Computer aided design and testing. Propagation of radio waves.

Suggested Text:

Wave Propagation and Antenna by Vargs Kraus
Elements of Electromagnetic, by M. N.O. Sadiku, Oxford University Press.

COMPUTER ENGINEERING

CS-XXX Computer Communication Networking

Introduction: protocols and Architecture, Data transmission, Transmission Media, Data Encoding, Data Communication Interface, Data link Central, Multiplexing, Circuit Switching, Packet Switching, ATM and Frame Relay, Congestion Central in data networks, LAN technology, LAN systems, Internet protocols, Inter network operation, Transport Protocols, ISDN and broad ban ISDN.

Suggested text:

Computer and Data Communication by William Stllinf.
Computer Communication and Networking Technologies by William M. Hancock.
Understanding Data Communication and Networks by William A. Shy.

CS-XXX Computer Graphics

Architecture and implementation of display and interaction devices, 2D and 3D vision, clipping and transformation, raster graphics scan conversion algorithms, hidden lines, edges and surface removal algorithms, rendering shading algorithms.

Suggested Text:

Gillies & Burger, *Interactive Computer Graphics*, Addition Wesley, 1989

Foley & Wamdem, *Fundamentals of Interactive Computer Graphics*, Addison Wesley.

EE-XX X Digital Instrumentation

Study of conventional Electronic Test and Measurement instruments. Review of sensors and transducers. Automatic Testing and Measurement instruments. Applications of computers in automatic testing and in day to day applications such as Biomedicine, Radars etc.

Suggested Text:

Noltingk B.E, *Instrumentation*, 2nd Ed. 1995, Butterworth Heinemann.

EL-XXX Digital System Design

Digital system design hierarchy, structural, behavioral and physical considerations. Design methodologies for combinational and sequential circuits using MS/LSI modular devices such as MUX, PLA, GAL and ROM. Design and analysis of algorithmic and finite state machines. Synchronous and asynchronous sequential machines. Basic microprocessor design conventions, register transfer, busing and sequencing of control. Introduction to a hardware description language for control programs. Digital logic testing and simulation. Approaches to combinational and sequential circuit testing, analysis of faulted circuits. Fault simulation techniques for parallel and concurrent faults.

CS-XXX Artificial Intelligence and Neural Network

Types of Intelligence, cognitive models, knowledge representation, pattern matching, Functional programming in LISP (or Prolog), Goal-based systems, heuristic search and games, expert systems., Language understanding, robotics and computer vision, theorem proving and deductive systems and learning. Applications using commercially available expert systems

Introduction to neural networks basic building blocks of neural networks, Hebb network, Perception networks, Adline networks, Hetro associative memory neural networks, auto associative nets, recurrent net, Hop field net, bi-directional associative memory (BAM) maxnet, hamming net, Kohonen self organizing maps, learning vector quantization (LVQ), adoptive resonance theory (ART) back propagation net.

Suggested Text:

Walker, *Knowledge Systems and PROLOG*. Addison-Wesley.

Winston. *Artificial Intelligence*, Addison-Wesley.
Rich, *Artificial Intelligence*. McGraw-Hill.

CS-XXX Micro-Controller Based Design

PIC16 MCU RISC architecture, PIC16 instruction set, project implementation, Motorola 68000 architecture, programming and project.

Suggested Text:

Embedded MCU Handbook, MCU 68000 Handbook.

CS-XXX Parallel Processing

Data parallelism, multi-processor architecture, process communication, data sharing, synchronous parallelism, multi-computer architecture, data partitioning, distributed memory, scheduling parallel program, object oriented parallel program.

Suggested Text:

Ted, G. Lewis, Hesham El-Rewani, *Introduction to Parallel Computing*, Prentice Hall, 1992.

Bruce P. Lester, *The Art of Parallel Programming*, Prentice Hall, 1993.

BIOMEDICAL ENGINEERING

BM-XXX Biomedical Instrumentation

Physiologic origin of bio-potentials, principles and design of biomedical instruments, transduction methods, advanced electronics, and electrical safety.

Introduction to Biomedical Instrumentation, Development of Biomedical Instrumentation, Problems encountered in measuring living systems.

Cardiovascular measurement Electro Cardiography, Measurement of Blood pressure, Blood flow and Cardiac output

ECG, DEFIBRILLATOR, B.P. APPARATUS CARDIOGRAPHIC, CARDIAC OUTPUT METER

PATIENT CARE AND MONITORING: Diagnosis, Calibration, and repair ability of patient monitoring equipment, Pacemakers and Defibrillators.

PATIENT MONITORS, ANGIOGRAPHY, DEFIBRILLATOR

MEASUREMENT IN THE RESPIRATORY SYSTEM:

Gas Exchange and distribution, Respiratory therapy equipment.

LIFE SAVING EQUIPMENT, ANESTHESIA, O.T. AND THERAPEUTIC

NONINVASIVE DIAGNOSTIC INSTRUMENTATION TEMP: Measurement, principles of Ultrasonic measurement.
VARIOUS TEMP: MEASURING EQUIPMENT, US MACHINE
BIOTELEMETRY
Physiological parameters
Adaptable to biotelemetry, Components of biotelemetry system, implantable units.
ENERGY EQUIPMENT FOR ACUTE PATIENT, CARDIOVASCULAR EQUIPMENT
X-RAY AND RADIOISOTOPE INSTRUMENTATION
Generation of Ionization radiation, Instrumentation for diagnostic X-rays, Instrumentation for the Medical use of Radio Isotopes, Radiation Therapy
GEBERAK RADUIGRAOGTM FKYIRISCIOTM C, T, M NRUM
NAMOGRAPHY, LITHTRIPTOR, MOBILE C-ARM, GAMMA CAMERA, RADIO THERAPIC EQUIPMENT.

BM-XXX Fields, Forces and Flows in Physiology

Conduction, diffusion, convection in electrolytes; fields in heterogeneous media; electrical double layers; Maxwell's stress tensor and electrical forces in physiological systems. Fluid and solid continua; equations of motion useful for porous, hydrated biological tissues. Clinical examples: membrane transport, electrode interfaces; electrical, mechanical, and chemical transduction in tissues; electro-phonetics, electro-osmotic flows; diffusion/reaction; ECG. Electromechanical and physicochemical interactions in bio-materials and cells.

BM-XXX Bio-Electric Signal Analysis and Interpretation

Detailed study of bio-electric signals that can be recorded from awake humans. Alternative recording and signal processing procedures with attention to relative advantages and disadvantages, including instrumentation requirements and examples. Mathematical models that relate signal parameters to physiological events. Examples given to demonstrate the applicability of bio-electric signals to control devices external to the body.

BM-XXX Diagnostic Imaging Systems

Methods of obtaining useful images of the interior of the body and industrial objects using x-rays, ultra-sound, and radio-nuclides. Image formation and display. Projection radiography. Radiation detectors. Conventional and

computerized tomography. Nuclear imaging. Ultra sonic imaging. Automated diagnosis and non-destructive testing. Radiational safety.

BM-XXX Biomedical Fluid Mechanics

Engineering characterization of fluid flow in cardio-vascular, respiratory, renal, and urological systems. Basic anatomy and physiology. Rheology of blood and other biological fluids. Velocity distributions and dynamic flow properties. Principles of regulation of flows.

BM-XXX Biomaterials

Fundamental materials; properties considered for biological materials; Thermodynamic, informational and structural properties; Implant materials: Metal, ceramic, polymeric material. Consideration of design and control of the interface between tissues and the material; interaction of materials with body: corrosion, biomechanics, and biocompatibility.

MASTER'S DEGREE IN ELECTRICAL ENGINEERING

M.Engg. /M.Sc/M.E programme in Electrical Engineering with specialization in Power System, Electrical Machines and Power electronics, Control Systems and Telecommunications, is recommended as follows.

POWER SYSTEMS

1. High Voltage Engineering.
2. Power System Circuit breaks and sub-station
3. Power System Analysis.
4. Power System Transmission
5. Power System Distribution.
6. Power System Reliability
7. Power System Protection
8. Insulation Coordination in Power System
9. Economic Power Dispatch.
10. Electric and Magnetic fields.
11. Power System Control
12. Energy Management.
13. Power System Stability
14. Computer Methods in Power System Analysis.

ELECTRICAL MACHINES AND POWER ELECTRICS

1. Control of DC Machines and Drives
2. Control of A.C. machines and Drives
3. Power Evaluation Drives
4. Power electronics Converters
5. Switch – mode Power supplies.
6. Modeling and simulation of Electrical Machines.
7. Special Electrical Machines.
8. Electrical Machine Design.
9. Advanced Control System.

CONTROL SYSTEMS

1. Linear Control System
2. Non Linear Control System
3. Linear Multivariable control theory
4. Control System Optimization
5. Optimal Control System.
6. Random variable and stochastic process
7. Stochastic Process in Electrical Engineering.

8. Estimation Theory
9. Adaptive Control systems.
10. Stochastic Control
11. Digital Control System.
12. Dynamics of Robots
13. Introduction to chaos theory
14. Chaos Theory & Fractals

TELECOMMUNICATION

1. Probability and Random Processes
2. Communication Systems
3. Information Theory & Coding
4. Digital Communication Theory
5. Communication Networks
6. Microwave Systems
7. Principles of Radar and Navigational Systems
8. Digital Signal Processing
9. Mobile Telephone Systems
10. Signal Detection and Estimation
11. Optical Fiber Communication
12. Satellite Communication
13. Radio Wave propagation
14. Image and Video Processing

RECOMMENDATIONS

In order to meet the objectives, the committee recommends the following:

1. The entire curriculum should be spread over four (4) academic years or eight (8) academic terms/semesters or twelve (12) academic quarters.
2. The entire curriculum should cover a set of core courses (essential for electrical engineering degree), and a set of electives which shall determine the specialization, namely:-
 - a) Electronics Engineering
 - b) Communication Engineering
 - c) Power Engineering
 - d) Computer Engineering
 - e) Biomedical Engineering
3. The core courses are recommended to be made compulsory in all universities of Pakistan and a set of electives may be chosen to fulfill the complete curriculum requirement. The electives proposed by the Committee may not be considered as complete. Universities may introduce additional electives to meet their peculiar requirements on the recommendations of their own faculty. Similarly the text books recommended for some subjects may not be considered mandatory. These books are meant as a guideline only.
4. A set of at least 40 courses from those proposed here comprising of both core and elective courses must be completed.
5. The faculty members teaching the courses should encourage design and independent thought in the students. This can be achieved by arranging for good quality text books and coupling each course with computer simulation exercises and mini-projects, where possible.
6. Field training is recommended for all engineering students. The duration of this training is recommended to be of 6 weeks. Further it is recommended that this training may be held in 3rd or 4th academic year.

7. Occasional industrial visits for final year students may be arranged. The students may be asked to submit reports with emphasis on application of the theory witnessed during the visit.
8. All subjects may not be coupled with laboratories. Laboratories may be offered as separate subjects in each year and should cover the scope of more than one course. However, the courses, which cannot be properly taught independently without laboratories, should continue according to the present arrangement.
9. It is recommended that the students be assigned self learning exercises to develop self confidence and a sense of learning.
10. The final year project should involve analysis, design and practical work. The successful completion of this project must continue to be a requirement for the fulfillment of the requirements for the B.Sc./B.E. Electrical Engineering degree.

For Postgraduate programme

Due to the variations in expertise and facilities in different universities of Pakistan, a more flexible type of Master's Degree programme is recommended as follows:

11. The course titles of the M.Engg. /M.Sc. /M.E in Electrical Engineering with specialization in Power Systems, Electrical Mechanics and Power Electronics, Control Systems, and Tele Communication, have been outlined. The details of courses content, structure, and requirement of programs is the responsibility of the individual university according to the suitability and needs.
12. Master's level programme may be run in the evening and qualified faculty members may be employed on part time basis.
13. The programme may be either by course work only or by course work and a Dissertation, or by research only. Universities may offer as many options as deemed fit.
14. The laboratory work may be associated with the courses where necessary
15. The Dissertation, where applicable is a partial requirement to be fulfilled along with the necessary course work except the thesis based on Research only.

16. The Dissertation shall be assigned to the students on individual basis and not to a group of student
17. In evaluating the student grading system may be followed.
18. Sessional marks shall be awarded in each course work on the basis of tests, assignments, etc.
19. The total number of credit hours required for the award of the degree shall be decided by the university offering the programme.
20. Minimum 75% attendance is mandatory for appearance in the examination.
21. The minimum duration for the programme shall be two years and maximum five years.
22. The program may also be run in the day time where enough resources are available.

-sd-
(Prof. Dr. Talat Altaf)
Convener

-sd-
(Engr. Faizullah Mahar)
Member/Secretary