CURRICULUM

OF

ELECTRONICS

BS & MS

(Revised 2017)

HIGHER EDUCATION COMMISSION
ISLAMABAD
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PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic program are required to undergo to achieve some specific objectives. It includes scheme of studies, objectives & learning outcomes, course contents, teaching methodologies and assessment/evaluation. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authorities to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), and Act of Parliament No. X of 1976 titled “ Supervision of Curricula and Textbooks and Maintenance of Standard of Education”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula regularly through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education which is at par with indigenous needs and international standards, HEC NCRCs have developed unified framework/templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering.

It is hoped that this curriculum document, prepared by the respective NCRC’s, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC http://hec.gov.pk/english/services/universities/RevisedCurricula/Pages/default.aspx

(Muhammad Raza Chohan)
Director General (Academics)
CURRICULUM DEVELOPMENT

STAGE-I

CURRI. UNDER CONSIDERATION

COLLECTION OF EXP NOMINATION UNI, R&D, INDUSTRY & COUNCILS

CONS. OF NCRC.

PREP. OF DRAFT BY NCRC

STAGE-II

CURRI. IN DRAFT STAGE

APPRAISAL OF 1ST DRAFT BY EXP

FINALIZATION OF DRAFT BY NCRC

PRINTING OF CURRI.

STAGE-III

FINAL STAGE

PREP. OF FINAL CURRI.

FINALIZATION OF DRAFT BY NCRC

PRINTING OF CURRI.

STAGE-IV

FOLLOW UP

QUESTIONNAIRE

COMMENTS

REVIEW

ORIENTATION COURSES BY LI, HEC

BACK TO STAGE-I

Abbreviations Used:

NCRC. National Curriculum Revision Committee
VCC. Vice Chancellor’s Committee
EXP. Experts
COL. Colleges
UNI. Universities
PREP. Preparation
REC. Recommendations
LI Learning Innovation
R&D Research & Development Organization
HEC Higher Education Commission
CONS: Constitution
Curri: Curriculum
Imple. Implementation
CURRICULUM DEVELOPMENT CYCLE

STEP 1: Nominations from all Stakeholders
STEP 2: Selection of Relevant Members
STEP 3: Formulation of NCRC
STEP 4: Preliminary Meeting/Preparation of Draft
STEP 5: Circulation of Draft for feedback (Local/Foreign)
STEP 6: Convening of Final NCRC
STEP 7: Dissemination (Website/Hard copies)
STEP 8: Composing/Printing
INTRODUCTION

Final meeting of the National Curriculum Revision Committee (NCRC) on Electronics program took place on May 22-24, 2017, at the Regional Centre of the Higher Education Commission in Lahore. The objective of the meeting was to revise and finalize the BS/MS Electronics curriculum to bring it in line with the BS/MS Program framework approved by HEC in April 2007. The following members of the committee were present in the meeting:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name &amp; Address</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Prof. Dr. M. Junaid Mughal, Chairperson / Professor, Department of Electrical Engineering, COMSATS Institute of Information Technology, Park Road, Chak Shahzad, Islamabad.</td>
<td>Convener</td>
</tr>
<tr>
<td>2.</td>
<td>Dr. Muhammad Khurram Bhatti Assistant Professor, Department of Electrical Engineering, Information Technology University, 6th Floor, Arfa Software Technology Park, 346-B, Lahore.</td>
<td>Secretary</td>
</tr>
<tr>
<td>3.</td>
<td>Prof. Dr. Amir Qayyum, Professor/Dean QEC, Department of Electrical Engineering, Capital University of Science &amp; Technology, Kahuta Road, Zone-V, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>4.</td>
<td>Dr. Azhar A. Rizvi, Professor, Department of Electronics, Quaid-i-Azam University, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>5.</td>
<td>Dr. Aqeel Abbas Bukhari, Assistant Professor, Department of Electronics, Quaid-i-Azam University, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>6.</td>
<td>Dr. Abdul Jalil Professor, Department of Electrical Engineering, International Islamic University, A-008, Ibn Khaldon Block, Islamabad.</td>
<td>Member</td>
</tr>
<tr>
<td>7.</td>
<td>Prof. Dr. Madad Ali Shah, Professor / HoD, Department Electrical Engineering, Sukkur Institute of Business Administration (IBA), Airport Rd, Sukkur.</td>
<td>Member</td>
</tr>
<tr>
<td>8.</td>
<td>Dr. Sadia Muniza Faraz, Assistant Professor, Department of Electronic Engineering,</td>
<td>Member</td>
</tr>
</tbody>
</table>
The meeting started with the recitation from the Holy Quran. Ms. Syeda Sanober Rizvi, Deputy Director (Curriculum), HEC, Islamabad, welcomed the participants on behalf of the Chairman HEC and briefed the participants on the policies of HEC about the revision of the sciences curricula in the light of the BS/MS Sciences Program framework. Ms. Rizvi requested the Convener, Prof. Muhammad Junaid Mughal, Professor at the Department of Electrical Engineering, COMSATS Institute of Information Technology, Chak Shahzad, Islamabad, to conduct proceedings of all technical sessions of the meeting for three days. The convener started proceedings of the meeting in accordance with the agenda.

The Convener, Prof. Dr. M. Junaid Mughal, briefed the curriculum revision committee on the need to have new curricula for BS/MS Electronics program. He said that the objective of the program was to bring the sciences program at par with the international standards and meet the needs of the industry. He further said that the key considerations in the science education should be to give the students a strong foundation about fundamental principles, improve their communication skills, develop and promote problem-solving and self-learning skills, and expose the students to the social sciences. The convener emphasized the need to provide guidelines for Program Learning Objectives (PLOs) and Course Learning Objectives (CLOs) and synchronize the proposed scheme of studies for BS/MS Electronics program in accordance with the proposed guidelines. The committee, after in-depth
discussions, revised the electronics curriculum and brought it in line with the approved BS Program framework of HEC. Following sub-committees were made to discuss various disciplines of the curriculum:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Broad Areas</th>
<th>Committee Members</th>
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<tbody>
<tr>
<td>1.</td>
<td>Program Outcomes/Objectives</td>
<td>Dr. Amir Qayyum&lt;br&gt;Dr. Muhammad Khurram Bhatti</td>
</tr>
<tr>
<td>2.</td>
<td>Computing, Digital Electronics, and Semiconductor Design</td>
<td>Dr. Madad Ali Shah&lt;br&gt;Mr. Muhammad Abid&lt;br&gt;Dr. Sadia Muniza Faraz&lt;br&gt;Dr. Muhammad Ali Nizamani</td>
</tr>
<tr>
<td>3.</td>
<td>Communications</td>
<td>Dr. Abdul Jalil&lt;br&gt;Dr. M. Junaid Mughal</td>
</tr>
<tr>
<td>4.</td>
<td>Circuits</td>
<td>Dr. Azhar A. Rizvi&lt;br&gt;Dr. Aqeel Abbas Bukhari&lt;br&gt;Dr. Kelash Kanwar Karmani</td>
</tr>
<tr>
<td>5.</td>
<td>Control Systems</td>
<td>Dr. Attaullah Khirdani</td>
</tr>
</tbody>
</table>

The Committee revisited the curriculum subject-wise. After three days rigorous deliberations, the committee unanimously approved the outlines of draft curriculum of the BS & MS Electronics degree program.
Electronics

Electronics is an important discipline that finds its use in a large number of applications. Continual advances in electronics in the areas of materials, processes, devices and circuits have been leading to rapid advances in the existing applications of electronics as well as in the emergence of new applications. To harness the full potential of developments in electronics and further advance the technologies related to electronics, it is important to have strong BS Electronics program to educate and train individuals in this key discipline of science. Keeping in mind the overall objectives to be achieved through this program of study, the curriculum of BS Electronics has been developed.

Learning Objectives:

It is envisioned that all institutions will make efforts to follow the Outcome Based Education (OBE) system and focus on the learning and growth of the students. The curriculum is designed to enable the students to learn, understand, and apply the fundamental and advanced concepts of electronics. This curriculum should be taught in such a manner that it produces scientists with sufficient hands-on skills and problem-solving mindset, in order to contribute effectively in the profession. In order to derive the maximum benefits from this curriculum, the students should be provided ample opportunities to polish their communication skills, exhibit ethical behavior and effective leadership, and prepare themselves to be a responsible professional of the society.

Expected Outcomes:

Following the Outcome Based Education (OBE) approach and focusing on the learning of the students, the proposed curriculum has been designed to produce graduates with the following attributes and outcomes:

Learning Outcome 1 – Knowledge: Ability to apply knowledge of mathematics and sciences in the field of electronics.

Learning Outcome 2 – Analysis: Ability to identify scientific problems, as well as to analyze and interpret data

Learning Outcome 3 – Design and Problem Solving: Ability to formulate or design electronic systems as well as to solve problems related to the discipline

Learning Outcome 4 – Technical Skills: Ability to use the techniques, skills, and modern scientific tools necessary for professional practice

Learning Outcome 5 – Teamwork: Ability to function effectively in multidisciplinary teams

Learning Outcome 6 – Ethics: Ability to apply ethical principles and commit to professional ethics and responsibilities
Learning Outcome 7 – Communication Skills: Ability to communicate effectively both verbally and in writing

Learning Outcome 8 – Impact on Society: Ability to understand the impact of scientific solutions in a global and societal context

Learning Outcome 9 – Lifelong Learning: Ability to recognize importance and engagement in lifelong learning

Learning Outcome 10 – Leadership: Ability to demonstrate effective leadership and decision-making skills.
Curriculum Review Basis – BS Degree

The curriculum for the undergraduate degree program is based on the Standardized Format/Scheme of Studies for Four-Year Integrated Curricula for Bachelor Degree in Basic, Social, Natural and Applied Sciences (Annexure I):

**Duration:**
- Total duration: Four (4) calendar years
- Total number of semesters: Eight (8)
- Duration of a semester: Sixteen (16) to eighteen (18) weeks

**Eligibility Criteria:**
- Minimum Level: Intermediate or equivalent degree
- Pre-requisite courses: Physics and Mathematics
- Minimum Grade: Second division

**Credit Hours:**
- Total number of credit hours: 124 to 136
- Contact hours: One (1) contact hour per week for each credit hour of theory course, Three (3) contact hours per week for each credit hour of lab course

Curriculum Review Basis – MS Degree:

The curriculum for the graduate degree program is based on the following considerations:

**Duration:**
- Total duration: Two (2) years
- Total number of semesters: Four (4)
- Duration of a semester: Sixteen (16) to eighteen (18) weeks

**Eligibility Criteria:**
- BS electronics or equivalent degree

**Credit Hours:**
- Total number of credit hours: 30 (24 Credit hours of coursework and 6 credit hours of thesis)
- Contact hours: One (1) contact hour per week for each credit hour of theory course
### Scheme of Studies for BS Degree

<table>
<thead>
<tr>
<th>No.</th>
<th>Course Title</th>
<th>Lec</th>
<th>Lab</th>
<th>CR</th>
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<td>Calculus and Analytical Geometry</td>
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<td>Islamic Studies/Ethics</td>
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<td><strong>THIRD SEMESTER</strong></td>
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<td>Circuit Theory-II</td>
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<td>Complex Variables and Transforms</td>
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### FOURTH SEMESTER

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<tr>
<td>1</td>
<td>Signals and Systems</td>
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<tr>
<td>2</td>
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<td>4</td>
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<td>Electronic Circuit Design</td>
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<td>Linear Algebra</td>
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**Semester Total**

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**Second Year Credit Hours**

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### THIRD YEAR

#### FIFTH SEMESTER

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<td>Microprocessors and Microcontrollers</td>
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<td>Probability and Random Variables</td>
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**Semester Total**

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### SIXTH SEMESTER

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**Total**

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**Third Year Credit Hours**

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### FOURTH YEAR

#### SEVENTH SEMESTER

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BS Elective Courses – to be updated

The list of electives given below is not exhaustive; the university/institute may add an elective based on available expertise. **Minimum Credit Hours of Elective Course selected will be 3 Hrs:**

- Industrial Electronics
- Introduction to Robotics
- Industrial Automation
- Power Electronics
- Opto-electronics
- Laser and Fiber Optics
- Advance Computer Programming
- Optimal Communication Systems
- Biomedical Instrumentation
- Nanotechnology
- Linear Integrated Circuits
- Antennas & Wave Propagation
- Transmission Lines and Antennas
- Artificial Intelligence
- Pattern Recognition
- Embedded Systems
- Digital Control Systems
- Digital Image Processing
- Information & Coding Theory
- Wireless Communication
- Satellite Communication
- Renewable Energy
DETAIL OF COURSES
First Semester

Course Title: English – I (Functional English)
Credit hours: 3 (3+0)
Prerequisites: None

Course Objectives: Enhance language skills and develop critical thinking.

Course Contents:
Basics of Grammar, Parts of speech and use of articles, Sentence structure, active and passive voice, Practice in unified sentence, Analysis of phrase, clause and sentence structure, Transitive and intransitive verbs, Punctuation and spelling.

Recommended Books:

Course Name: Introduction to Computing
Credit hours: 3(2+1)
Prerequisites: None

Course Objectives:
To teach the structure, operation, programming and applications of computers. To familiarize with Windows Operating system and its administration. Familiarization with MS-Office and algorithm design.

Course Contents:
Lab outline:
Lab work will be in accordance with the course outline.

Recommended Books:

Course Name: Calculus and Analytical Geometry
Credit hours: 3 (3+0)
Prerequisites: None

Course Objectives:
Teach the concepts of calculus and analytic geometry, and the applications of these concepts to the solution of engineering problems.

Course Outline:
Introduction to functions, introduction to limit, derivatives and their applications, integral calculus with applications, vector algebra, vector calculus, introduction to analytical geometry, straight line in R3 planes, cylindrical and spherical coordinates, surfaces, cylinders and cones, spheres, spherical trigonometry.

Recommended Books:

Course Name: Physics - I
Credit hours: 4 (3+1)
Prerequisites: None

Course Objectives: Understand the concepts of force, energy and wave properties, optics and thermodynamics.

Course Outline:
Review of vector analysis, vector field, line integral, surface integral, volume integral, gradient of vector field, divergence and curl of vector, transformation between coordinates; motion in one, two and three dimensions; Newton’s laws of motion and its applications, work and kinetic energy, potential energy and conservation, momentum, impulse and collision; rotation of rigid bodies,
dynamics of rotational motion, torque and angular momentum; periodic motion, simple harmonic motion and examples, waves, types of waves, waves on strings, general wave equation and plane wave solution, electromagnetic waves, interference, diffraction and polarization.

**Recommended Books:**

**Course Name:** Islamic Studies/Ethics  
Credit hours: 2 (2+0)  
Prerequisites: None

**Course Objectives:**  
To provide Basic information about Islamic Studies, to enhance understanding of the students regarding Islamic Civilization, to improve Students skill to perform prayers and other worships, to enhance the skill of the students for understanding of issues related to faith and religious life.

**Course Content:**  

Recommended Books:
1. Hameed ullah Muhammad, “Emergence of Islam”, IRI, Islamabad
2. Hameed ullah Muhammad, “Muslim Conduct of State”
3. Hameed ullah Muhammad, ‘Introduction to Islam
4. Mulana Muhammad Yousaf Islahi,”
Second Semester

**Course Name:** English – II (Communication Skills)  
Credit hours: 3 (3+0)  
Prerequisites: None

**Course Objectives:**  
Enable the students to meet their professional life communication needs.

**Course Contents:**  
Practice in writing a good, unified and coherent paragraph, essay writing, CV and job application, Translation skills, Urdu to English, Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension, Letter/memo writing, minutes of meetings, use of library and internet, Personality development (emphasis on content, style and pronunciation)

**Recommended Books:**  
5. Reading and Study Skills by John Langan, Study Skills by Riachard York.

**Course Name:** Circuit Theory-I  
Credit hours: 4 (3+1)  
Prerequisites: None

**Course Objectives:**  
To introduce the basic concepts and physical principles of electrical circuits.

**Course Content:**  
Physical Foundations: electric current, electromotive force, resistance, ohm’s law, energy and power; Circuit Elements: resistors, capacitors, inductors, ideal vs non-Ideal sources; Resistive Circuits: KVL, KCL, series/parallel configurations, voltage divider, current divider, equivalent resistance, Wye-Delta transformations, Thevenin and Norton equivalent circuits; Mesh and Node analysis; Network Theorems (Superposition, Thevenin’s, Norton’s, and Maximum Power Transfer) with independent and dependent sources; alternating current fundamentals; phasor representation of alternating current;
AC voltage and current relationships for pure resistive, inductive and capacitive circuits. Introduction to operational amplifier.

**Lab Outline:**
Lab content should be in accordance with the course outlines.

**Recommended Books:**

**Course Name:** Differential Equations  
Credit hours: 3 (3+0)  
Prerequisites: Calculus and Analytical Geometry

**Course Objective:**
To introduce basic techniques pertaining to matrices and formulation/solution of differential equations.

**Course Content:**

**Recommended Books:**
1. Modern Differential Equations by Abell and Braselton, McGraw-Hill

**Course Name:** Physics - II  
Credit hours: 3(3+0)  
Prerequisite: Physics-I

**Course Objectives:**
Teach the fundamentals and applications of thermodynamics, electrostatics, magneto statics, electrodynamics, and Maxwell’s equations. Derivation of wave equation and plane wave solution.

**Course Content:**
Temperature and heat, thermal properties of matter, kinetic theory of gases, First Law of Thermodynamics, Second Law of Thermodynamics, entropy; electric charge, Coulomb’s Law, electric field due to point charge, electric fields due to various charge distributions, electric field of a dipole, electric field lines, flux of electric field, Gauss’s Law and its applications; insulators, conductors and semiconductors; charge distribution on conductors, electric potential and potential difference, electric potential due to various charge distributions, equipotential surface, calculation of field from potential; dielectrics, capacitance, parallel-plate capacitor, other capacitor configurations, capacitors in series and parallel, energy in capacitors; current and current density, resistivity and conductivity, Ohm’s Law, electric power, emf, magnetic fields, magnetic field of current and magnetic force on current-carrying wire, motion of a charged particle in a uniform electric and magnetic fields, e/m for electron and use of CRO, magnetic field of coil and torque on a current loop, force between two parallel currents carrying conductors and definition of Ampere, solenoids and toroids, Faraday’s Law of induction, induced current and emf, Lenz’s Law, inductance, inductance of solenoid, self- and mutual induction

**Recommended Books:**
Course Name: **Solid State Electronics**  
Credit hours: 3 (3+0)  
Prerequisites: None

**Course Objectives:**  
To teach fundamental concepts of solid state Physics, Quantum mechanics and quantum effects. To impart the knowledge of semiconductor materials and their devices. To understand the electrical behavior of semiconductor devices under varying excitation conditions.

**Course Content:**  
Semiconductor crystal lattices, planes and directions. Introduction to Quantum Mechanics, Schrodinger’s wave equation, electron in free space, infinite and step potential function, extensions of wave theory to atoms. Allowed and forbidden energy bands, electrical conduction in solids, effective mass theorem, Boltzmann transport theory and distribution function, space lattices, atomic bonding, impurities and imperfection in solids, energy band structure, generation, recombination and carrier lifetimes, carrier transport phenomena, high field transport, impact ionization, Carrier diffusion, drift and high field effect, mobility and conductivity, velocity saturation, Hall effect with applications to electronic devices, graded impurity distribution, homo-junction and hetero-junction properties of semiconductor devices and theories underlying the static/dynamic characteristics of semiconductor devices. Optical absorption, luminescence, photoconductivity, direct and indirect recombination, photoconductive devices, quasi Fermi level, Haynes-Schokley experiment.

**Recommended Books:**  

Course Name: **Pakistan Studies**  
Credit hours: 2 (2+0)  
Prerequisites: None

**Course Objectives:**  
Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan. Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

**Course Content:**  
Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah, Factors leading to Muslim separatism, People and Land, Indus Civilization, Muslim advent,

**Recommended Books:**
Third Semester

Course Name: English – III (Technical Report Writing)
Credit hours: 3 (3+0)
Prerequisites: None

Course Objectives:
Enhance language skills and develop critical thinking.

Course Contents:

Recommended Books:

Course Name: Basic Electronics
Credit hours: 4 (3+1)
Prerequisites: Solid State Electronics

Course Objectives: To introduce the basics of semiconductors electronic devices and circuits.

Course Contents:
Introduction to semiconductor devices: pn-junction, semiconductor diodes, forward and reverse-bias characteristics of diode, equivalent circuit of diode, DC load line; Diode Applications: half-wave and full-wave rectifiers, clipper and clamper circuits, diode as a switch, and special purpose diodes; Bipolar Junction Transistor (BJT): transistor operation, npn and pnp transistors, transistor DC biasing, common-emitter configuration, common base configuration, common collector configuration, DC and AC analysis of BJT, small and large signal models; Field-Effect Transistor (FET), types of FET, theory and operation of FETs and MOSFETs, biasing techniques and characteristics, common-drain configuration, common-source configuration, common-gate configuration, fixed bias and self-bias configurations, voltage divider biasing, JFET and MOSFET bias curves, DC and AC analyses of FET; Introduction to operational amplifier; Basics of digital electronics.
Lab Outline:
Lab content should be in accordance with the course outlines.

Recommended Books:

Course Name: Circuit Theory-II
Credit hours: 4 (3+1)
Prerequisites: Circuit Theory-I

Course Objectives:
To introduce the analysis of Alternating Current (AC) electrical circuits, their frequency response, and transfer functions.

Course Contents:
Integro-differential equations for linear circuits: First, second, and higher order linear circuits, transient and steady state response for source free and with source, complete response for RLC circuits, resonance, lossless LC circuits, complex forcing functions. Sinusoidal Steady State Analysis: phasor relations of network variables, impedance and admittance, quality factor, power factor, theorem of maximum power transfer, sinusoidal steady state response, complex network function, resonant circuits, filter circuits; two ports and multi-port circuits; magnetically coupled circuits; mutual inductance; ideal and real transformers; hybrid parameters; interconnection of two port networks; two-port BJT circuits.

Lab outline:
Lab content should be in accordance with the course outlines.

Recommended Books:
Course Title: Complex Variables and Transforms
Credit Hours: 3 (3+0)
Prerequisites: Differential Equations

Course Objectives:
Introduce the concepts of complex variables, Laplace transform, Fourier transform, and use of transforms in the solution of engineering problems

Course Content:
Introduction to complex number systems, Argand’s diagram, modulus and argument of a complex number, polar form of a complex number, De Moivre’s theorem and its applications, complex functions, analytical functions, harmonic and conjugate, harmonic functions, Cauchy-Riemann. Introduction to complex number systems, Argand’s diagram, modulus and argument of a complex number, polar form of a complex number, De Moivre’s theorem and its applications, complex functions, analytical functions, harmonic and conjugate, harmonic functions, Cauchy-Riemann equations, line integrals, Green’s theorem, Cauchy’s theorem, Cauchy’s integral formula, singularities, poles, residues, contour integration and applications; Laplace transform definition, Laplace transforms of elementary functions, properties of Laplace transform, periodic functions and their Laplace transforms, inverse Laplace transform and its properties, convolution theorem, inverse Laplace transform by integral and partial fraction methods, Heaviside expansion formula, solutions of ordinary differential equations by Laplace transform, applications of Laplace transforms; series solution of differential equations, validity of series solution, ordinary point, singular point, Forbenius method, indicial equation, Bessel's differential equation, its solution of first kind and recurrence formulae, Legendre differential equation and its solution, Rodrigues formula; Fourier transform definition, Fourier transforms of simple functions, magnitude and phase spectra, Fourier transform theorems, inverse Fourier transform, solutions of differential equations using Fourier transform.

Recommended Books:

Course Name: Computer Programming
Credit hours: 3 (2+1)
Prerequisites: Introduction to Computing

Course Objectives:
To introduce the fundamental concepts of structured and object-oriented programming.

Course Content:
Overview of computer programming and languages used for the programming. Fundamental Programming Constructs: data types, variables, basics of input
and output, loops and decisions. Functions, structures, arrays and strings, pointers. Structured and Modular Programming. Program Development: analyzing problems, designing algorithm/solution, and translating algorithms into programs. Object oriented programming and software development: objects, classes, operator overloading, encapsulation, inheritance and polymorphism. Exception handling, testing and debugging designed solution.

**Lab outline:**
Lab work will be in accordance with the course outline.

**Recommended Books:**
Fourth Semester

Course Name: Signals and Systems
Credit hours: 4 (3+1)
Prerequisites: Complex Variables and Transforms

Course Objectives:
To provide understanding on classification of signals and systems. Teach the time and frequency domain analysis techniques for continuous and discrete time signals and linear systems.

Course Content:
Continuous-time and discrete-time signals; periodic signals, even and odd signals, exponential and sinusoidal signals, the unit impulse and unit step functions, continuous-time and discrete-time systems; linear time invariant (LTI) systems, difference equation, complex frequency analysis (s-domain) causality, BIBO stability, convolution and correlation, Discrete Time Fourier Transforms, time and frequency characterization of signals and systems, the sampling theorem, aliasing, sampling the discrete time signals, z-transform, analysis and characterization of LTI systems using z-transform, Introduction to Analog filter design.

Lab outline:
Lab work will be in accordance with the course outline.

Recommended Books:

Course Name: Digital Logic Design
Credit hours: 4 (3+1)
Prerequisites: None

Course Objectives:
Understand various logic gates, Boolean algebra and logic circuit simplification techniques. Understand the concepts of combinational and sequential logic circuits, and Programmable Logic Devices. Apply Boolean algebraic principles for design of combinational and sequential circuits. Apply acquired knowledge to implement small-scale digital logic circuits.

Course Content:
Overview of number system, Logic gates and Boolean algebra, Sum of Product (SOP) and Product of Sum (POS), Truth table simplification, Karnaugh map,
Quine mcCluskey, Combinational logic design including: adders, comparators, decoders, encoders, code converters, multiplexers/de-multiplexers, Sequential circuit design, flip-flops, registers, state machines, Synchronous and asynchronous counters, counter applications, Semiconductor memory, static and dynamic RAM/ROM, flash and special types of memories, Introduction to programmable logic devices (PAL, PLD’s, FPLDs and FPGAs).

Lab outline:
Lab work will be in accordance with the course outline.

Recommended Books:
3. Digital Fundamentals by Floyd, Pearson; 11 edition (July 24, 2014)

Course Name: Electronic Circuit Design
Credit hours: 4 (3+1)
Prerequisites: Basic Electronics

Course Objectives:
Enable the students to analyze and design practical circuits using discrete circuit elements.

Course Contents:
Amplifier Circuits: Transistor as an amplifier, small signal analysis, large-signal analysis, single stage, multistage amplifiers; Classes of Amplifiers: Class A, B, AB, and C amplifiers, push-pull amplifier, complementary symmetry amplifier; Coupled Amplifiers: RC-coupled, transformer coupled, direct coupled amplifiers; Frequency response of the amplifiers, audio frequency amplifiers, radio frequency amplifiers, tuned amplifiers; feedback in amplifiers, effect of feedback on frequency response; Practical Amplifier Considerations: input and output impedance matching, amplifier loading; Oscillator Circuits: basic theory, tank circuit, damped and undamped oscillations, phase-shift oscillator, Colpitt oscillator, Hartley oscillator, Wein-bridge oscillator, Clapp oscillator, crystal Oscillator; Analogue Filter Circuits.

Lab outline:
Lab contents will be in accordance with the course outline.

Recommended Books:
Course Name: Linear Algebra
Credit hours: 3 (3+0)
Prerequisites: None

Course Objectives:
Introduce the matrix theory and use of matrices in the solution of engineering problems.

Course Content:
Algebra of matrices; inverse of a matrix; Gauss-Jordan method for the solution of a system of linear algebraic equations; vectors in the plane and in three dimensions; vector functions; vector spaces; subspaces; span and linear independence; basis and dimension; homogeneous systems; coordinates and isomorphism; rank of a matrix; determinant; inverse of a matrix; applications of determinants; determinants from a computational point of view; properties of determinants; eigenvalues and eigenvectors; systems of linear differential equations; diagonalization; Hermitian matrices; singular value decomposition; quadratic forms; positive definite matrices; non-negative matrices; floating-point numbers; Gaussian elimination; pivoting strategies; matrix norms and condition numbers; orthogonal transformations; eigenvalue problem; least square problems.

Recommended Books:

Course Name: General-I
Credit hours: 3 (3+0)
Fifth Semester

Course Name: Integrated Circuits
Credit hours: 3 (3+0)
Prerequisites: Electronic Circuit Design

Course Objectives:
To develop understanding of analog, digital electronic circuits and operational amplifier. To impart knowledge about the fabrication of electronic devices and comparison of the performance of integrated circuits.

Course Content:
Detailed design of pulse and switching circuits, switch; nonstable, a stable and bitable circuits; emitter-coupled flip-flop; noise margin; fan-out; propagation delay; Schmitt trigger; saturating and non-saturating logic families (DTL, TTL, ECL, I2L, CMOS); detailed study of timer ICs and their applications; analog and digital circuit interface with applications; introduction to the fabrication of digital microelectronic pMOS, nMOS, CMOS, and BiCMOS circuits; epitaxy, ion implantation and oxidation; differential amplifiers: DC and AC analysis of differential amplifier; design of simple differential amplifier; level translator; current sources (simple current mirror, Widler and Wilson current source): output stage design; use of op-amp as a circuit element, offset and offset compensation, op-amp with negative feedback, frequency response of an op-amp, DC and AC analysis of op-amp ICs.

Recommended Books:

Course Name: Microprocessors and Microcontrollers
Credit hours: 4 (3+1)
Prerequisites: Digital Logic Design

Course Objectives:
Define and explain the architecture, programming, interfacing, and applications of microprocessors and microcontrollers. Understand and apply the fundamentals of assembly level programming. Familiarize with parallel, serial interfacing and interrupt programming.

Course Contents:
Introduction to microprocessor and microcontrollers, basic concepts, control unit, internal registers, ALU of an 8-bit or 16-bit microprocessor, timing and sequencing, peripherals and interfacing, memory and I/O synchronization, wait
state, hardware single stepping, memory speed requirements, logic levels, loading and buffering. Understanding the instruction set, data transfer, logic operations and branching, programmed I/O interrupts, microprocessor system design, machine code and assembly language programming, Applications of microcontrollers

**Lab outline:**
Lab work will be in accordance with the course outline.

**Recommended Books:**

**Course Name:** Probability and Random Variables
Credit hours: 3 (3+0)
Prerequisites: None

**Course Objectives:**
To introduce the fundamentals of probability and random variables with applications to practical problems, primarily chosen from areas of computer networks, communication, signal processing, control, estimation, reliability and engineering decision making. The course will emphasize to equip students with the basic tools required to build and analyze probability models in the context of science

**Course Outline:**
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.

**Recommended Books:**

Course Name: Instrumentation and Measurements
Credit hours: 4 (3+1)
Prerequisites: None

Course Objectives:
The introduction and understanding of the principles and methods of measurements. The study of instruments for the measurement of electrical and non-electrical quantities.

Course Content:
Basic principal of measurement, Precision measurements terminologies principles of different measurement techniques; Types of measurement devices, construction and working of different analog and digital meters, measurement of physical quantities, measurement methods, error theory, structure of measurement, transducers, signal conditioning, sensors and condensers, types of signal conditioning, Measurement displays, LCD, CRT, etc.) Recording frequency meters phase meters digital voltmeter, oscilloscope. Sensitivity, accuracy, and uncertainty; instruments for measurement of electrical properties, pressure, temperature, position, velocity, flow rates (mass and volume) and concentration, modern instrumentation techniques; static and dynamic responses of instrumentation principles of operation, signal generators, power and energy meters; high-voltage measurements.

Lab outline:
Lab work will be in accordance with the course outline.

Recommended Books:

Course Name: Linear Control Systems
Credit hours: 4 (3+1)
Prerequisites: Complex Variables & Transforms

Course Objectives:
To introduce the basic concepts of feedback, automatic control system, their transfer functions, shifting properties from time domain to frequency domain,
design of compensation techniques using lead compensator, lag-compensator and Lead/lag compensator, etc.

**Course Content:**
What is control system terminology, Introduction to control problems; open-loop and closed-loop systems, transfer functions, block diagrams, signal flow graphs; introduction to modeling; formation of differential equations of electrical, mechanical and other systems, steady-state and transient response of first-order, second-order and higher-order systems, transfer functions; stability, Routh’s stability criterion, types and analysis of feedback control systems; Root Locus analysis, Bode plots, Nyquist stability criterion, gain and phase margins; introduction to state-space concepts and design techniques, formation and solution of state equations, eigenvalues and eigenvectors, compensation techniques; PID controllers.

**Lab outline:**
Lab contents will be in accordance with the course outline.

**Recommended Books:**
Course Name: Electromagnetic Field Theory
Credit hours: 3 (3+0)
Prerequisites: Physics - II

Course Objectives:
Teach the concepts and mathematical methods to understand and analyze electromagnetic fields and waves.

Course Content:

Recommended Books:

Course Title: Communications Systems
Credit Hours: 4 (3+1)
Prerequisites: Signals and Systems

Course Objective:
This course is structured as a senior-level course emphasizing fundamental communication principles and application of these principles to contemporary analogue and digital communication systems.

Course Outline:
Introduction to communication systems: Fundamental terms and definitions, information, message signal, analog and digital signals, Elements of communication systems (Transmitter, Channel, Receiver), performance measure and design tradeoffs, signal transmission through a linear system and signal distortion over communication channel. Modulation: Amplitude modulation and demodulation, carrier acquisition, angle modulation schemes, concept of instantaneous frequency, generation of modulated signals, spectral analysis of angle modulation schemes, demodulation of angle modulation. Baseband Modulation: Binary pulse modulation, M-arypulse modulation,
probability of error in M-ary pulse Modulation, pulse shaping, ISI, signal space. Band pass Digital Modulation: Amplitude modulation/detection of digital signals, phase modulation/detection of digital signals, probability of error for DPSK. Performance of communication systems in the presence of noise, review of random process and variables, statistical modeling of noise. Introduction to information theory.

Lab outline:
Lab contents will be in accordance with the course outline.

Recommended Books:

Course Name: Digital Signal Processing
Credit Hours: 4 (3+1)
Prerequisites: Signals and Systems

Course Objectives:
This course aims to develop mathematical and analytical skills necessary to analyze digital signals both in time and frequency domains.

Course Content:

Lab outline:
Lab contents will be in accordance with the course outline.

Recommended Books:
Course Name: Embedded System Design
Credit hours: 4 (3+1)
Prerequisites: Microprocessor and Microcontroller

Course Objectives:
To address the trends and challenges in the design of embedded systems and teach chip technologies. To gain hands-on experience of design tools and implementation of embedded systems using various processors.

Course Contents:
Trends and challenges in embedded system design, Advanced Microcontrollers including PIC and AVR microcontroller architecture and programming. Design and development of hardware and software for standalone embedded systems using digital signal processors/FPGAs. Comparative analysis of various embedded systems for cost effective solutions.

Lab work:
Lab work will be in accordance with the course outline.

Recommended Books:

Course Name: General-II
Credit Hours: 3 (3+0)
Seventh Semester

Course Name: VLSI Design
Credit hours: 3 (3+0)
Prerequisites: Digital logic design

Course Objectives:
To give an introduction and understanding of concepts of the implementation of VLSI designs for digital systems. To develop the understanding of Transistor-Level Logic Design, CMOS Digital Chip Design and evaluation of Gate Functions and Timing Characteristics.

Course Content:
Transistor topology, transistor equations, CMOS process steps, design rules for custom layout; CMOS logic design, complex gates, BiCMOS circuits, pseudo, NMOS, dynamic logic, dynamic cascaded logic, domino logic, 2 and 4 phase logic, pass transistor logic; control and timing, synchronous and asynchronous, self-timed system, multiphase clocks, examples of ALU, shifters and registers; layout, hand layout, graphical layout, low-level languages, design rule checking, placement of cells, simulation of design, test pattern generation, high-level languages, structured design methodology for FLSI, hierarchical design techniques and examples. ultra-fast VLSI circuits and systems, and their design; digital and analog architectures, serial addition, bit-serial multipliers, systolic arrays, future integrated circuit processing, effect of scaling circuit dimensions, physical limits of device fabrication. Clocking and Timing Issues. Layout of digital circuits. HDL Programming in Verilog.

Recommended Books:

Course Name: Data Communication and Networks
Credit Hours: 4 (3+1)
Prerequisites: Communication Systems

Course Objective:
To apprehend basics of data communication and to identify applications of data/computer communication networks and understands the current state of the telecommunications industry.
Course Content:

Voice-over-IP, RTP, SIP, Classes of Service, Diffserv

Lab outline:
Lab contents will be in accordance with the course outline.

Recommended Books:

Course Name: Elective-I
Credit Hours: 3/4 (3+0/1)

Course Name: Elective-II
Credit Hours: 3/4 (3+0/1)

Course Name: Research Project-I
Eighth Semester

Course Name: Microwave Electronics
Credit hours: 4 (3+1)
Prerequisites: Electromagnetic Theory

Course Objectives:
To introduce the analysis and design of microwave passive and active components, devices and circuits.

Course Contents:
RF and Microwave frequencies and technology, Passive microwave components: resistors, capacitors and inductors at RF and microwave frequencies; Transmission lines: coaxial lines, strip line, Slot line, coplanar line, and suspended-substrate strip line; Waveguides and its types (rectangular and circular etc.), Analysis and optimization of transmission lines: Impedance matching, Standing Wave Ratio (SWR), reflection loss, impedance matching on Smith chart, Passive microwave devices and circuits: directional couplers, isolators, circulators, resonant circuits, passive filter design, Active microwave components; Diodes, Transistor at RF frequencies, Small signal RF amplifier design, RF power amplifier, Quantum electron devices, microwave mixers and detectors, principle of RADAR.

Lab outline:
Lab contents will be in accordance with the course outline.

Recommended Books:

Course Name: Elective-III
Credit Hours: 3 (3+0)

Course Name: Elective-IV
Credit Hours: 3 (3+0)

Course Name: Research Project - II
SCHEME OF STUDIES FOR MS DEGREE

Masters (MS) degree in electronics is a two years’ full time degree. Minimum requirement for MS degree award is of 30 credit hours. MS program shall have course work of 24 credit hours and research work of 6 credit hours (spread over minimum of two semesters, excluding summer semester). If the research work is extended to more than two semesters the credit hours shall still be counted as 6 credit hours. Maximum duration of full time MS degree is 3 years.

Course work of 24 credits hours (8 courses of 3 credit hours each) shall be divided into two (6 credit hours) core course, and 18 credit hours of elective courses (6 courses, 4 to 6 courses from their area of specialization and may be 1 to 2 courses from any other area of specialization or one additional core course). The students may also register additional courses in addition to the above requirements as non-credit/audit courses.

Credit hours distribution:

<table>
<thead>
<tr>
<th>S. No</th>
<th>Course Area</th>
<th>Number of Courses to be studied</th>
<th>Credits hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Core Courses</td>
<td>2 to 4</td>
<td>6 to 12</td>
</tr>
<tr>
<td>2</td>
<td>Area of Specialization</td>
<td>4 to 6</td>
<td>12 to 18</td>
</tr>
<tr>
<td>3</td>
<td>From Other Specializations</td>
<td>0 to 2</td>
<td>0 to 6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>8 (courses)</td>
<td>24 (credit hours)</td>
</tr>
</tbody>
</table>

The core courses are designed with the view that the student should acquire a solid foundation in advance mathematical skills and physical principles. However, elective courses are designed to give an in-depth knowledge and skill in a particular research area to the student. It is advised that students should learn courses from related fields also to have a broader academic base. The universities can design more elective courses, according to the strength of their faculty, keeping in view the above guideline.

If there is some laboratory work required in any core or elective course, it may be treated as part of the course and no separate credits hours shall be assigned to it. The laboratory work can be graded as part of the course.

The graduate students should be allowed to register the research thesis only after they have cleared a minimum of 15 credit hours (including the two core courses).
Core Courses:
1. Mathematical Methods for scientists
2. Optimization Theory
3. Stochastic Processes
4. Linear System Theory

Course Name: Mathematical Methods for Scientists
Credit hours: 3 (3+0)
Prerequisites: None

Course Objectives:

Course Contents:
Solutions of linear and nonlinear differential equations and initial value and boundary value problems; Approximate solutions of differential equations; Exact and approximate solution of difference equations; Special Functions; Asymptotic expansion of integrals; Laplace’s Method and Watson’s Lemma for integrals; Methods of stationary phase; Method of steepest decent; Asymptotic evaluation of integrals.

Recommended Books:

Course Name: Optimization Theory
Credit hours: 3(3+0)
Prerequisites: Instructor consent

Course Objectives:
The objective of this course is to make students acquire a systematic understanding of optimization techniques. The problem formulation and the solution approaches through linear optimization techniques is addressed. Student will be able to address a class of nonlinear optimization problems where the optimal solution is also globally optimal, i.e. convex nonlinear optimization and its variants.

Course Contents:
Linear optimization, Nonlinear optimization, Linear programming, Introduction to convex sets, Geometry of linear programming and Duality theory, Variants of linear programming, Nonlinear programming, Convex optimization
problems, quadratic optimization, geometric optimization, geometric
interpretation, optimality conditions. Dual decomposition, augmented
Lagrangians and the method of multipliers, alternating direction method of
multipliers, optimality conditions and stopping criterion.

**Recommended Books:**
1. Introduction to Linear Optimization by Dimitris Bertsimas & John N.
   University Press.
3. Engineering Optimization: Theory and Practice by, John Wiley & Sons
   2009.
4. David G. Luenberger and Yinyu Ye, Linear and Nonlinear Programming,

**Course Name:** Stochastic Processes
Credit hours: 3(3+0)
Prerequisites: Instructor consent

**Course Objectives:**
To develop an ability to model dynamical processes with noise as stochastic
processes, understanding of important qualitative characteristics of stochastic
processes and improve skill to analyze some basic stochastic processes.

**Course Contents:**
Introduction to sequence of random variables and multi-variable distributions;
models of stochastic processes; stationary stochastic processes and their
applications; Ergodicity; Markov processes, Markov chains, continuous
Markov chains; renewal processes; Birth-death processes; time series
applications in stochastic processes in filtering, reliability and forecasting,
prediction and control

**Recommended Books:**
5. Roy D. Yates, David J. Goodman, “Probability and Stochastic Processes,
   A friendly Introduction for Electrical and Computer Engineers”, 1999, John
   Wiley & Sons.
Course Name: Linear System Theory
Credit hours: 3 (3+0)
Prerequisites: Instructor consent

Course Objectives:
This graduate level course focuses on linear system theory in time domain. The course introduces the fundamental mathematics of linear spaces, introduction to first-order and second order models, conversion techniques from time domain to state-space models, linear operator theory and then proceeds with existence and uniqueness of solutions of differential equations.

Course Contents:
Linear algebra review, solutions of linear differential equations, state space representations, State transition matrix, time varying systems, time invariant systems, the fundamental matrix. Structural properties of linear systems, single input and single output system. Multi-input and multi-output system, controllability, observability and stability, realizations and minimality. Synthesis of linear controllers, pole placement, state feedback, observer design. Linear Quadratic Regulator theory, introduction to robust control.

Recommended Books:
MS Elective Courses

- Semiconductor Devices and Technology
- Electromagnetic Field Theory
- Modelling and Simulation of Semiconductor Devices
- Microprocessor-Based System Design
- Computer Architecture
- Digital System Design
- FPGA-Based System Design
- Communication Systems
- Digital Signal Processing
- Design of Electronic Systems
- Integrated Circuit Design
- Digital Integrated Circuits for Communication
- Optoelectronic Devices
- Nanotechnology
- Linear Integrated Circuits
- Fiber Optics and Integrated Optics
- Digital Control
- Multi-rate Systems and Filter Banks
- Power Electronic Devices
- Bio-Electric Signal Analysis and Interpretation
- Microelectronic Technology
- Power Electronics
- Digital Instrumentation Systems
- Industrial Electronics
- VLSI Design
- FPGA-Based System Design
- Digital Image Processing
- Pattern Matching and Recognition
- Digital Control Systems
- Digital System Design
- Embedded System Design

(All courses are of 3 Credit hours)

The list of elective courses given above is in no respect exhaustive, it is given here as a guideline. The universities can add more elective courses as per their faculty strength and academic procedures. However, the aim to give the graduate students a solid foundation in the chosen field should be kept in sight.

Total Credit Hours = 30 (including 6 credit hours of thesis’).

* The duration of the thesis should be at least two semesters.
### Annexure I

**STANDARDIZED FORMAT / SCHEME OF STUDIES FOR FOUR-YEAR INTEGRATED CURRICULA FOR BACHELOR DEGREE IN BASIC, SOCIAL, NATURAL AND APPLIED SCIENCES**

#### STRUCTURE

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Categories</th>
<th>No. of courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min – Max</td>
<td>Min – Max</td>
</tr>
<tr>
<td>2.</td>
<td>General Courses to be chosen from other departments</td>
<td>7 – 8</td>
<td>21 – 24</td>
</tr>
<tr>
<td>3.</td>
<td>Discipline Specific Foundation Courses</td>
<td>9 – 10</td>
<td>30 – 33</td>
</tr>
<tr>
<td>4.</td>
<td>Major Courses including research project / Internship</td>
<td>11 – 13</td>
<td>36 – 42</td>
</tr>
<tr>
<td>5.</td>
<td>Electives within the major</td>
<td>4 – 4</td>
<td>12 – 12</td>
</tr>
</tbody>
</table>

**Total**

40 – 44

124 – 136

- Total numbers of Credit hours: 124-136
- Duration: 4 years
- Semester duration: 16-18 weeks
- Semesters: 8
- Course Load per Semester: 15-18 Cr hr
- Number of courses per semester: 4-6 (not more than 3 lab/practical courses)

#### Compulsory Requirements

**Compulsory Requirements**

*(the student has no choice)*

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cr. hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ENGLISH I</td>
<td>3</td>
</tr>
<tr>
<td>2. ENGLISH II</td>
<td>3</td>
</tr>
<tr>
<td>3. ENGLISH III</td>
<td>3</td>
</tr>
<tr>
<td>4. ENGLISH IV/ UNIV. OPTIONAL * (G1)</td>
<td>3</td>
</tr>
<tr>
<td>5. PAKISTAN STUDIES</td>
<td>2</td>
</tr>
<tr>
<td>6. ISLAMIC STUDIES / ETHICS</td>
<td>3</td>
</tr>
<tr>
<td>7. MATHEMATICS I</td>
<td>3</td>
</tr>
<tr>
<td>8. MATHEMATICS II / UNIV. OPTIONAL **</td>
<td>3</td>
</tr>
<tr>
<td>9. INTRODUCTION TO COMPUTER</td>
<td>3</td>
</tr>
</tbody>
</table>

9 Courses

25 Credit hours

#### General Courses to be chosen from other departments

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cr. hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Physics I</td>
<td>4</td>
</tr>
<tr>
<td>2. Physics II</td>
<td>3</td>
</tr>
<tr>
<td>3. CVT</td>
<td>3</td>
</tr>
<tr>
<td>4. Linear Alg.</td>
<td>3</td>
</tr>
<tr>
<td>5. Computer Pr.</td>
<td>3</td>
</tr>
<tr>
<td>6. Probability</td>
<td>3</td>
</tr>
<tr>
<td>7. General II</td>
<td>3</td>
</tr>
</tbody>
</table>

7 Courses

21-24 Cr. hours

#### Discipline Specific Foundation Courses

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cr. hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Circuit Th I</td>
<td>4</td>
</tr>
<tr>
<td>2. Solid S. E.</td>
<td>3</td>
</tr>
<tr>
<td>3. Basic Elec.</td>
<td>4</td>
</tr>
<tr>
<td>4. Circuit Th II</td>
<td>4</td>
</tr>
<tr>
<td>5. DLD</td>
<td>4</td>
</tr>
<tr>
<td>6. Signal &amp; Sy.</td>
<td>4</td>
</tr>
<tr>
<td>7. ECD</td>
<td>3</td>
</tr>
<tr>
<td>8. EMT</td>
<td>3</td>
</tr>
<tr>
<td>9. IC</td>
<td>3</td>
</tr>
</tbody>
</table>

9 Courses

30-33 Credit hours

33
<table>
<thead>
<tr>
<th>Major courses including research project/internship</th>
<th>Elective Courses within the major</th>
</tr>
</thead>
<tbody>
<tr>
<td>11-13 courses</td>
<td>4 courses</td>
</tr>
<tr>
<td>36-42 Credit hours</td>
<td>12 Credit Hours</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cr. hr</th>
<th>Subject</th>
<th>Cr. hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Micropr.</td>
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<td>1. Elective I</td>
<td>3/4</td>
</tr>
<tr>
<td>2. Project I</td>
<td>3</td>
<td>2. Elective II</td>
<td>3/4</td>
</tr>
<tr>
<td>3. Project II</td>
<td>3</td>
<td>3. Elective III</td>
<td>3</td>
</tr>
<tr>
<td>4. IM</td>
<td>4</td>
<td>4. Elective IV</td>
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</tr>
<tr>
<td>5. LCS</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6. Comm. Sy</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>7. DSP</td>
<td>4</td>
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<td></td>
</tr>
<tr>
<td>8. Emb. Sys</td>
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<td></td>
</tr>
<tr>
<td>9. VLSI</td>
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<td></td>
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</tr>
<tr>
<td>10. Data Co</td>
<td>4</td>
<td></td>
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</tr>
<tr>
<td>11. Micro El</td>
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<td>11 Courses</td>
<td>41</td>
<td>4 Courses</td>
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* University has the option to recommend any other course in lieu of English IV.

** University may recommend any other course in lieu of Mathematics II.
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<th>Name of Subject</th>
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<tr>
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<tr>
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<td>GENERAL-I</td>
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<td>GENERAL-II</td>
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<td></td>
<td>FOUNDATION-I</td>
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<tr>
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<td>Third</td>
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<td>GENERAL-V</td>
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<tr>
<td>MAJOR-XII</td>
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<td>3-4</td>
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<tr>
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<tr>
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<tr>
<td><strong>TOTAL – 124-136</strong></td>
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<td>15-17</td>
</tr>
</tbody>
</table>

* 4 Cr Hr must include Lab/Practicals