CURRICULUM
OF
ELECTRICAL ENGINEERING
B.Sc./BE/BS
&
M.Sc./ME/MS
(Revised 2012)

HIGHER EDUCATION COMMISSION
ISLAMABAD
CURRICULUM DIVISION, HEC

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Mr. Muhammad Javed Khan        Adviser (Academic)
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Composed by: Mr. Zulfiqar Ali, HEC, Islamabad
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The curriculum of subject is described as a throbbing pulse of a nation. By viewing curriculum one can judge the stage of development and its pace of socio-economic development of a nation. With the advent of new technology, the world has turned into a global village. In view of tremendous research taking place world over new ideas and information pours in like of a stream of fresh water, making it imperative to update the curricula after regular intervals, for introducing latest development and innovation in the relevant field of knowledge.

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

In compliance with the above provisions, the HEC undertakes revamping and refurbishing of curricula after regular intervals in a democratic manner involving universities/DAIs, research and development institutions and local Chamber of Commerce and Industry. The intellectual inputs by expatriate Pakistanis working in universities and R&D institutions of technically advanced countries are also invited to contribute and their views are incorporated where considered appropriate by the National Curriculum Revision Committee (NCRC).

A committee of experts comprising of conveners from the National Curriculum Revision Committees of HEC in the disciplines of Basic, Applied, Social Sciences, Agriculture and Engineering met in 2007 & 2009 and developed the unified templates to standardize degree programmes in the country so as to bring the national curriculum at par with international standards, and to fulfill the national needs. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education.

In line with above, NCRC comprising senior university faculty and experts from various stakeholders and the respective accreditation councils has finalized the curriculum for Electrical Engineering. The same is being recommended for adoption by the universities/DAIs channelizing through relevant statutory bodies of the universities.

MUHAMMAD JAVED KHAN
Adviser (Academics)

April, 2012
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

STAGE-III
FINAL STAGE
PREP. OF FINAL CURRI.
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
INTRODUCTION

The role of science and engineering in the economic development of a nation and the prosperity of its people is very important and it is imperative for a nation to train its workforce in contemporary disciplines of science and engineering. At the same time, body of scientific knowledge is expanding rapidly and new technologies are emerging at a fast pace setting new standards of academic learning and learning outcomes. In order to stay at par with international standards, it is essential to periodically review and update science and engineering curricula being taught in Pakistani universities. The Higher Education Commission (HEC) has devised a mechanism that ensures periodic review and updating of curricula being offered at the universities in Pakistan through the National Curriculum Revision Committees (NCRC). NCRC is constituted from amongst the faculty members of both public and private sector universities and industry professionals in the subject area under review. Similarly HEC constituted NCRC in 2011 for revision of Electrical Engineering curricula and its variants being taught in Pakistani universities.

The NCRC that was constituted comprised of faculty members and industry professionals in Electrical Engineering who because of job requirements or nomenclature used in their respective departments could broadly be categorized as: (i) Power (Systems) Engineers; (ii) Electronics Engineers; (iii) Communication/Telecommunication Engineers and (iv) Computer (Systems) Engineers. Despite being under the umbrella of Electrical Engineering, the categorization in association with a specific variant of Electrical Engineering also reflected the trends in Pakistani institutions. Some offer Electrical Engineering degrees as such, and some by nomenclature of its variants such as (i) Power (Systems) Engineering; (ii) Electronic Engineering; (iii) Communication/Telecommunication Engineering and (iv) Computer (Systems) Engineering. The degrees offered by the names of variants of Electrical Engineering reflect the content of the curriculum to a certain extent. However, there is no uniformity in the context understood by the nomenclature of Electrical Engineering. For example, Electrical Engineering degree offered by NED UET, Karachi and MUET, Jamshoro, imply Power (Systems) Engineering only, whereas the degree offered with the same nomenclature at UET, Lahore, UET Peshawar and NUCES (FAST) imply Electronics & Communication Engineering as well as Power (Systems) Engineering. However, it is a general consensus that the four variants enumerated above are specialized streams of the original Electrical Engineering discipline. The same can be verified by inspection of curricula of major Pakistani universities in the discipline of Electrical Engineering or in the disciplines of any of its four variants. In view of this fact, it was but natural to constitute a NCRC that represents Electrical Engineering and its above mentioned four variants.

The objectives of the committee were:

i. To devise a curriculum that provides a unified framework (guidelines) to institutions offering degrees under the title of Electrical Engineering or under the title of the aforementioned four variants.
ii. To incorporate latest reading & writing material against each course.
iii. To bring uniformity and develop minimum baseline content in each and every course of study.
iv. To make recommendation, if any, for promotion/development of the discipline.

The committee held its first meeting in October 2011 at the HEC Regional Center at Lahore. The first draft was prepared and it was then dispatched to local and foreign experts for review. On receipt of the review report, final meeting of the committee was held in February 2012. The outcome of the final meeting is the curriculum that is described in the remaining document.

**Proceeding of the 1st meeting of NCRC held in October 2011:**

The mandate communicated to the committee by Mr. Muhammad Javed Khan, Adviser (Academics), HEC, Islamabad at the start of the meeting, was to come up with a uniform curriculum of Electrical Engineering that should encompass the need of all four areas whether currently being offered as separate disciplines or as specializations of Electrical engineering.

The curriculum committee used the HEC Curriculum template as the fundamental working document for engineering discipline. This template is also mandated by Pakistan Engineering Council (PEC). It breaks up the curriculum into engineering content and non-engineering content with the former covering between 65 - 70% of the curriculum and the later covering 35 - 30% of the remaining curriculum. Mathematics with the exception of Probability and Statistics has been included in the non-engineering content. The engineering content is further broken up into Interdisciplinary engineering electives (IDEE), Computing essentials, Foundation, Breadth (Core) and Depth (Core and Electives).

The committee decided that since a uniform curriculum is being developed with a nomenclature of Electrical Engineering, the non-engineering content, Computing essentials, IDEE and the Foundation would be identical. There was a discussion on IDEE because institutions offering each area as a separate degree under a separate department counted IDEE as being subjects of other areas. For example Electronics department would count subjects of Telecommunication as IDEE and vice versa. However, institutions offering Electrical Engineering degrees with specializations counted IDEE as subjects from other disciplines meaning Mechanical, Civil Engineering etc. However, it was decided by the committee to classify IDEE as subjects from other non-electrical engineering disciplines.

Since each area of Electrical engineering has progressed, the committee felt that Breadth and Depth might be different for each area under consideration while remaining under the common platform of Electrical Engineering.

Also, it was decided that the credit hours in the proposed curriculum scheme would remain within the limits of 130 - 136 as decided by HEC for undergraduate curriculum.

The committee recommends that a reasonable departure in contents from the contents of proposed curriculum may be expected by accrediting bodies like Pakistan Engineering Council. The term reasonable may be decided by the
Visitation team on merit and experience in consultation with the concerned university's officials. The committee also noted that the titles of a certain set of contents (subjects) offered by universities may differ from the titles proposed by this committee. Universities may break up contents or combine portions of contents as per their own peculiar requirements. The purpose of this proposed curriculum is to provide a uniform guideline to universities and institutions in Pakistan while developing their curriculum with an effort to have uniformity of standards in their programs.

**Minutes of HEC National Curriculum Revision Committee Final Meeting in Electrical Engineering, held from February 14-16, 2012.**

The final meeting of National Curriculum Revision Committee in the discipline of Electrical Engineering and its four variants/specializations, namely: Power (Systems), Electronics, Communication/Telecommunication and Computer (Systems) Engineering was held at HEC Regional Center Lahore from February 14-16, 2012. The following members attended the meeting:-

1. Prof. Dr. Muhammad Ali Maud, Chairman, Department of Computer Science and Engineering, University of Engineering & Technology, Lahore.  
   Convener

2. Prof. Dr. Muhammad Inayatullah Babar, Professor, Department of Electrical Engineering, University of Engineering & Technology, Peshawar.  
   Secretary

3. Prof. Dr. Shahzad A Malik, Chairman, Department of Electrical Engineering, COMSATS Institute of Information Technology, Park Road, Chak Shahzad, Islamabad.  
   Member

4. Dr. Haroon-ur-Rashid, Associate Professor and Head, Department of Electrical Engineering, Pakistani Institute of Engineering and Applied Sciences (PIEAS), Nilore, Islamabad.  
   Member

5. Dr. Intesar Ahmed, Head of Department, Electrical Engineering Lahore College for Women University, Lahore.  
   Member

6. Dr. Engr. Muhammad Khan Burdi, Professor, Department of Electrical Engg, College of Engg. & Tech, Islamia University, Bahawalpur.  
   Member
7. Engr. Dr. Bilal A. Alvi,
Head of Electrical Engineering Department,
College of Engineering & Sciences,
Institute of Business Management,
Korangi Creek Road, Karachi.

8. Engr. Dr. Syed Saad Azhar Ali,
Associate Professor,
Department of Engineering Science & Technology,
Iqra University, Defence View, Shaheed-e-Millat Road (Ext.), Karachi-7500.

9. Dr. Saad Ahmed Qazi,
Professor & Chairman, Department of Electrical Engineering,
NED University of Engineering & Technology,
University Road, Karachi-75270

10. Dr. Syed Muhammad Atif Saleem,
Assistant Professor, Department of Electrical Engineering,
FAST –National University,
ST-4, sector 17-D, Shah Latif Town, National Highway,
Karachi-75030

11. Dr. S. M. Ghazanfar Monir,
Associate Professor, Department of Electronics,
PAF-Karachi Institute of Economics and Technology (PAF-KIET),
Korangi Creek, Karachi – 75190.

12. Mr. Faizan Farid,
Manager, Instrumentation Division,
Pakistani Space & Upper Atmosphere Research Commission
SUPARCO HQ, Off University Road,
Karachi.

13. Dr. Zahoor Ahmad,
Associate Professor, Faculty of Engineering,
Balochistan University of Engineering and Technology (BUET), Khuzdar.

14. Dr. Shoailb Zaidi,
Professor & Chairman,
Department of Electronic &Telecomm Engineering,
NED University of Engineering & Technology,
University Road, Karachi 75270.

15. Dr. Syed Afaq Husain,
Faculty of Computing, Riphah International University,
Haji Camp, I-14, Islamabad.

16. Dr. Arshad Hussain,
Professor, Department of Electrical Engineering,
National University of Computer & Emerging Sciences
(NUCES),
Lahore Campus, Block B, Faisal Town,
Lahore.

17. Dr. Shahid Masud, Associate Professor, Department of Electrical Engineering, Lahore University of Management Sciences, Sector U, DHA, Lahore Cantt.

18. Engr. Muhammad Aamir, Assistant Professor & Lab Coordinator, Department of Electronic Engineering, Sir Syed University of Engineering & Technology, Karachi

19. Prof. Dr. Syed Madad Ali Shah, Professor & Chairman, Department of Electrical Engineering, Institute of Business Administration (IBA), Sukkur.

20. Dr. Anjum Ali, Prof. & Head of Department Electrical Engineering, National University of Computer & Emerging Sciences, B-Block, Faisal Town, Lahore

21. Dr. Asim Loan, Professor, Sultan Qaboos IT Chair, Department of Electrical Engineering, University of Engineering Technology, Lahore.

22. Dr. Bilal Shams, Assistant Professor, Department of Electrical & Computer Engineering, Kohat University of Science & Technology, Kohat – 26000.

23. Vice Chancellor and Prof. Naib Hussain, Department of Electrical Engineering, Department of Computer Systems Engineering, Mirpur University of Science and Technology (MUST), Mirpur.

24. Engr. Prof. Dr. Iftikhar A. Khan, Professor, Electrical Engineering Department, KPK University of Engineering & Technology, Peshawar.

25. Prof. Dr. Abdul Fattah Chandio, Professor, Department of Electronic Engineering, Quaid-e-Awam University of Engg, Science & Technology (QUEST), Nawabshah.

26. Prof. Dr. A. H. S Bukhari, Professor / Dean, Department of Electronic Engineering,
The meeting started with recitation from the Holy Quran by the convenor Prof. Dr. Muhammad Ali Maud. Malik Arshad Mahmood, Director Curriculum, HEC welcomed the members. Since the final meeting was a sequel of the preliminary meeting held in October 2011, majority of the participants were the same as in the previous meeting with some new members who were attending the meeting for the first time. After a general welcoming note by the Convenor, the
participants introduced themselves. The house was then opened to all participants to present their views on the first draft prepared after the preliminary meeting in October 2011.

The following points were raised by some of the members:

i. There is a need to revise and standardize the nomenclature of the undergraduate engineering degree to BS or BE instead of BSc as being practiced in some of our leading universities.

ii. The constitution of one NCRC to draft a curriculum of Electrical Engineering and four of its variants was hotly debated. This debate further raised the following reservations and objections:
   ▲ Some were of the opinion that separate NCRC should have been constituted for Electrical Engineering and separate NCRCs for each of its four variants.
   ▲ Some were of the opinion that this is transgressing over the autonomy of the universities offering separate degrees in Electrical Engineering and one or all four of its variants. Because the step of constituting one NCRC is, in their opinion, a precursor to declaring the four variants of Electrical Engineering as one discipline, which itself has far reaching repercussions on the organization and administrative structure of the universities.

After deliberations on the points raised by some of the members and after reviewing the autonomy of the universities granted to them under their charters, the house agreed on the following points which satisfied the doubts and apprehensions being felt by some of the members to a great extent and helped in defining the objectives of the NCRC meeting and its final expected outcome.

i. Deciding on the nomenclature of the degree is the prerogative of the university and beyond the scope of NCRC.

ii. Deciding on offering disciplines whether as specializations or as independent disciplines is again the prerogative of the university and beyond the scope of NCRC.

iii. The NCRC is a curriculum revision committee and it is mandated to limit itself to the task assigned to it. The current NCRC is large in size and encompasses all the four NCRCs constituted previously for each variant (stream) of Electrical Engineering namely, Power (Systems) Engineering (alias Electrical Engineering), Electronic Engineering, Communication/Telecommunication Engineering, and Computer (Systems) Engineering.

iv. The present NCRC shall thus review the curriculum of all the four variants (streams) of Electrical Engineering and identify commonalities in various domains of the curriculum of each variant. It shall then decide on a unified framework (guideline) curriculum that may be offered as Electrical Engineering as such or by the names of the variants by selective offering of electives.

After these discussions, following sub-committees were formed to look at the components of the electrical engineering programs (curriculum) and recommend course contents along with prerequisites, course description and suggest textbooks. It was also decided to discuss the recommendations of each sub-committee in the concluding combined meeting and recommend the final curriculum for approval by HEC. The sub-committees consisted of the following:
Non-Engineering Domain Component
1. Prof. Dr. Shahzad A. Malik (Convener)
2. Dr. Syed Madad Ali Shah
3. Dr. Syed Muhammad Atif Saleem
4. Engr. Muhammad Aamir
5. Dr. Izhar Hussain Zaidi

Foundation + Computing + Interdisciplinary Electives
1. Dr. M. Younus Javed (Convener)
2. Engr. Dr. Bilal A. Alvi
3. Dr. Engr. Muhammad Khan Burdi
4. Engr. Dr. Syed Saad Azhar Ali
5. Dr. Arshad Hussain
6. Prof. Dr. Muhammad Inayatullah Babar
7. Dr. Anjum Ali
8. Dr. Muhammad Bilal Malik
9. Dr. Jameel Ahmad
10. Dr. Syed Muhammad Atif Saleem

Computer (Systems) Engineering Core (Breadth) and Electives (Depth)
1. Dr. Syed Afaq Hussain (Convener)
2. Dr. Shahid Masud
3. Dr. Anjum Ali
4. Dr. Syed Muhammad Ghazanfar Monir
5. Prof. Dr. Shahzad A. Malik
6. Prof. Dr. Muhammad Akram Shaikh
7. Prof. Dr. Abdul Fattah Chandio

Power (Systems) Engineering Core (Breadth) and Electives (Depth)
1. Dr. Engr. Muhammad Khan Burdi (Convener)
2. Prof. Dr. Naib Hussain
3. Dr. Intesar Ahmad
4. Dr. Saad Ahmad Qazi
5. Engr. Prof. Dr. Muhammad Yunus Javed
6. Prof. Dr. Shahazad A. Malik

Communication/Telecom Engineering Core (Breadth) and Electives (Depth)
1. Dr. Arshad Hussain (Convener)
2. Dr. Shoaib Zaidi
3. Prof. Dr. Muhammad Inayatullah Babar
4. Dr. Syed Madad Ali Shah
5. Dr. Syed Muhammad Ghazanfar Monir
6. Engr. Dr. Bilal A. Alvi
7. Dr. Muhammad Bilal Malik
8. Dr. Bilal Shams
10. Dr. Zahoor Ahmad
11. Dr. Izhar Hussain Zaidi

Electronic Engineering Core (Breadth) and Electives (Depth)
1. Dr. Bilal A. Alvi (Convener)
2. Dr. Shoaib Zaidi
3. Engr. Muhammad Aamir
4. Dr. Jameel Ahmad
5. Eng. Dr. Syed Saad Azhar Ali
6. Prof. Dr. Abdul Fattah Chandio
7. Dr. A. H. S. Bukhari
8. Dr. Haroon-ur-Rashid

After thorough deliberation the committee unanimously approved the draft curriculum of the B.Sc/BE/BS & M.Sc/ME/MS in Electrical Engineering and its variants whether offered as separate disciplines or as specializations.

Concluding Remarks

Malik Arshad Mahmood, Director Curriculum HEC Islamabad thanked the Convener, Secretary and all members of the Committee for sparing their time and for their quality contributions towards preparation of the preliminary draft curriculum of the BE/BSc/BS and Masters programme.

The committee, in return, highly appreciated the efforts made by the officials of HEC Regional Centre, Lahore, Director Curriculum and Dy. Director Dr. Tahir Ali Shah for making nice arrangements to facilitate the forming of the committee and their accommodation at Lahore. The Committee also appreciated the input given by Mr. Muhammad Javed Khan, Adviser (Acad.) on different aspects of the programs under discussion during the preliminary meeting held in October 2011.

The Meeting ended with the vote of thanks to the HEC officials.
Curriculum Review Basis
BSc/BS/BE Degrees

The curriculum for the BSc/BS/BE degree programme is based on the following considerations:

Duration of the Degree Programme

Total duration: Four (4) academic years

System of Study

System: Semester System.
Total number of semesters: Eight (8)
Duration of a semester: Sixteen (16) weeks of instruction
Plus one (1) to two (2) weeks for examinations

Definition of Credit Hour

The term "Credit Hour (CH)" refers to a unit of academic credit during a semester. Each credit hour is related to a one or more "Contact hours per week" according to subject type, that is, whether Theory /Lecture or Practical/Laboratory.

Credit Hours Requirement for Undergraduate Degree

Total number of Credit Hours: 130 to 138

Definition of Contact Hours as Related to Credit Hours

Contact hours (Theory /Lecture): One (1) contact hour per week for each credit hour of Theory/Lecture.
Contact hours (Practical /Lab): Three (3) contact hours per week for Each credit hour of laboratory work.

Ratio of Engineering to Non-Engineering Subjects

Non-Engineering Subjects: 30–35%
Engineering Subjects: 65-70%

Classification of Engineering Subjects

Probability & Statistics, Computing Essentials, Interdisciplinary Engineering Electives (IDEE), Engineering discipline breadth (core) and depth (electives).

Classification of Non-Engineering Subjects

Humanities, Management Sciences and Natural Sciences.
## Recommended List of Non-Engineering Domain Courses

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<tr>
<th>Knowledge Area</th>
<th>Sub Area</th>
<th>Name of Course</th>
<th>Theory Contact Hours</th>
<th>Practical Contact Hours</th>
<th>Credit Hours (CH)</th>
<th>Number of Subjects</th>
<th>Total Credit Hours</th>
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<td>Management Sciences</td>
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<td>Professional Practice (or any other Management Course)</td>
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<td>Electives</td>
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* Multivariable Calculus/Complex Variables and Transforms/Discrete Mathematics/Numerical Analysis/Chemistry/Biology or related subject as appropriate for the programme.
Recommended List of Engineering Domain Courses in Electrical Engineering and also Applicable to its Variants/Specializations namely

(1) Electronic Engineering (2) Communication/Telecommunication Engineering and (3) Power (Systems) Engineering

<table>
<thead>
<tr>
<th>Knowledge Area</th>
<th>Name of Course</th>
<th>Theory Contact Hours</th>
<th>Practical Contact Hours</th>
<th>Credit Hours (CH)</th>
<th>Number of Subjects</th>
<th>Total Credit Hours</th>
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<td>Electrical Engineering Foundation</td>
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<td>Electrical Engineering Core (Breadth)</td>
<td>Communication Systems</td>
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<td></td>
<td>Linear Control Systems</td>
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<td>Electrical Engineering Specialization Based Electives (Depth)</td>
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<td>Depth Elective-IV</td>
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</table>
Recommended List of Elective Courses in Electrical Engineering Distributed According to Variants (Specializations/Streams)

Note:
The following list is not exhaustive. Universities /Institutes may expand the list as per their requirements.

1. Power (Systems) Engineering
   i. Power Distribution and Utilization (Breadth Core I)
   ii. Instrumentation and Measurements (Breadth Core II)
   iii. Advanced Electrical Machines
   iv. Power System Analysis
   v. Power Generation
   vi. Electrical Power Transmission
   vii. Power Electronics
   viii. Power System Protection
   ix. Power System Stability & Control
   x. Advanced Electrical Machine Design
   xi. High Voltage Engineering
   xii. Renewable Energy Systems
   xiii. Digital Signal Processing
   xiv. Digital Control Systems
   xv. Analog and Digital Communication Systems
   xvi. Integrated Electronic Circuits
   xvii. PLC and Industrial Drives

2. Communication/ Telecommunication Engineering
   i. Computer Communication Networks (Breadth Core I)
   ii. Electronic Circuit Design (Breadth Core II)
   iii. Digital Communications
   iv. Wave Propagation and Antennas
   v. Digital Signal Processing
   vi. Information Theory and Coding
   vii. Instrumentation and Measurements
   viii. Transmission and Switching Systems
   ix. Wireless and Mobile Communications
   x. Satellite Engineering
   xi. Optical Communication
   xii. RF and Microwave Engineering
   xiii. Navigation and Radar Systems
   xiv. Digital Image Processing
   xv. Antenna Theory and Design
   xvi. Mobile and Pervasive Computing
   xvii. Power Distribution and Utilization

3. Electronic Engineering
   i. Instrumentation and Measurements (Breadth Core I)
   ii. Electronic Circuit Design (Breadth Core II)
   iii. Power Electronics
   iv. Opto-Electronics
   v. VLSI Design
vi. Industrial Electronics  
vii. Digital Electronics  
viii. Introduction to Nano Technology  
ix. Digital Signal Processing  
x. Computer Communication Networks  
xi. Wave Propagation and Antenna  
xii. Digital Image Processing  
xiii. Mobile and Wireless Communication  
xiv. Solid State Devices  
xv. Digital Control Systems
# Recommended List of Engineering Domain Courses
## In Computer (Systems) Engineering

<table>
<thead>
<tr>
<th>Knowledge Area</th>
<th>Name of Course</th>
<th>Theory Contact Hours</th>
<th>Practical Contact Hours</th>
<th>Credit Hours (CH)</th>
<th>Number of Subjects</th>
<th>Total Credit Hours</th>
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<tr>
<td>Computing</td>
<td>Introduction to Computing</td>
<td>1</td>
<td>3</td>
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<td>Programming Fundamentals</td>
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<td>Data Structures and Algorithms</td>
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<td></td>
<td>Electronic Devices and Circuits</td>
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<td></td>
<td>Digital Logic Design</td>
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<td>Microprocessor Systems</td>
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<td>Core (Breadth)</td>
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<td>Software Engineering</td>
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</table>
Recommended List of Elective Courses in Computer (Systems) Engineering

1. Object-oriented Analysis and Design
2. Advanced Programming
3. Systems Programming
4. Software Quality Assurance and Testing
5. Software Project Management
6. Parallel and Distributed Computing
7. Digital Signal Processing
8. Digital Image Processing
9. Digital Communication
10. Multimedia Systems
11. Communication Systems
13. Artificial Intelligence
14. Digital System design
15. Embedded Systems
16. Linear Control Systems

Note
The above list is not exhaustive. Universities / Institutes may expand the list as per their peculiar requirements.

Course Outlines
Mathematics and Natural Sciences

Calculus and Analytic Geometry

Prerequisites: None

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

Course Outline:
Complex Numbers, DeMoivre’s Theorem and its Applications, Simple Cartesian Curves, Functions and Graphs, Symmetrical Properties, Curve Tracing, Limit and Continuity, Differentiation of Functions. Derivative as Slope of Tangent to a Curve and as Rate of Change, Application to Tangent and Normal, Linearization, Maxima/Minima and Point of Inflexion, Taylor and Maclaurin Expansions and their convergence. Integral as Anti-derivative, Indefinite Integration of Simple Functions. Methods of Integration: Integration by Substitution, by Parts, and by Partial Fractions, Definite Integral as Limit of a Sum, Application to Area, Arc Length, Volume and Surface of Revolution.

Recommended Books:

Linear Algebra

Prerequisites: None

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

Course Outline:

Recommended Books:

Differential Equations

Prerequisites: Calculus and Analytical Geometry

Objective:
Develop fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems.

Course Outline:
Recommended Books:

Multivariable Calculus

Prerequisites: Calculus and Analytical Geometry

Objective:
The goals are to develop the skills to have ground knowledge of multivariate calculus and appreciation for their further Engineering courses.

Course Outline:

Recommended Books:
1. "Multivariable Calculus: Early Transcendentals", (Stewart’s Calculus Series)

Complex Variables and Transforms

Prerequisites: Calculus and Analytical Geometry

Objective:
Develop fundamental skills complex variable analysis and apply it in solving differential equations through Laplace transform.

Course Outline:

Recommended Book:
Numerical Analysis

**Prerequisites:** Differential Equation, Multivariable Calculus.

**Objective:**
Teach the use of computers for the numerical solution of engineering problems

**Course Outline:**
Floating point number system, error analysis, solutions of equations, interpolation, splines, numerical differentiation and integration, numerical methods in linear algebra, systems of linear equations, method of least squares, eigenvalues, eigenvectors, solution of ordinary and partial differential equations. This subject is to be supplemented with extensive computer exercises.

**Recommended Books:**

General Physics I: Mechanics and Wave Motion

**Prerequisites:** None

**Course Outline:**

**Recommended Book:**
1. Halliday, Resnick and Walker, "Fundamental of Physics" (Latest Ed.)

General Physics II: Electricity and Magnetism

**Prerequisites:** General Physics I

**Course Outline:**

**Recommended Book:**
1. Halliday, Resnick and Walker, "Fundamental of Physics" (Latest Ed.)
Discrete Structures

Prerequisites: None

Objective:
Introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation for further work. Further, this course aims to develop understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through study of combinatorial reasoning, abstract algebra, iterative procedures, predicate calculus, tree and graph structures. In this course more emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.

Course Outline:
Introduction to logic and proofs: Direct proofs; proof by contradiction, Sets, Combinatorics, Sequences, Formal logic, Prepositional and predicate calculus, Methods of Proof, Mathematical Induction and Recursion, loop invariants, Relations and functions, Pigeonhole principle, Trees and Graphs, Elementary number theory, Optimization and matching. Fundamental structures: Functions; relations (more specifically recursions); pigeonhole principle; cardinality and countability, probabilistic methods.

Recommended Books:

COMPUTING

Introduction to Computing

Prerequisites: None

Objective:
To acquaint the students with the structure, operation, programming, and applications of computers

Course Outline:
History, classification, basic components, CPU, memory, peripheral devices, storage media and devices, physical and logical storage, data organization, file storage, programs and software, application software, operating systems, problem specification, flow chart, variables and constants, arrays, input/output, termination, social impact of computer age, computers in office, industry and education.
Lab Work Outline:
Basic computer organization including motherboard, memory, I/O cards, networking devices, use of flow charts, introduction to office tools including spreadsheet, word processing and presentation, introduction to mathematical software such as MATLAB, overview of different browsers, introduction to various operating systems, coding, executing and debugging simple programmes.

Recommended Books:
2. Patt and Patel, "Introduction to Computing Systems from Bits and Gates to C and Beyond", Mc-GrawHill
3. Lab handouts - miscellaneous

Programming Fundamentals

Prerequisites: Introduction to Computing

Objective: To acquaint the students with the fundamental concepts of structured and object oriented computer programming language such as C++ OR Java.

Course Outline:
Fundamental data types, abstract data types, arrays and matrices, records and pointers, linked lists, Introduction to Object oriented programming and software development, defining classes, selection statements, repetition statements, exceptions and assertions, arrays and collections, file I/O, inheritance and polymorphism, GUI and Event-driven programming.

Lab Work Outline:
Programming in C++ OR Java using simple programs for basic file I/O, single-dimensional arrays, two-dimensional arrays, sorting algorithm, problem solving in object-oriented paradigm, object oriented programme design process and tools, implementation of classes and derived classes, objects and encapsulation, operator and functions overloading, inheritance and polymorphism, GUI development.

Recommended Books:

Data Structures & Algorithms

Prerequisites: Programming Fundamentals

Objective: To understand the basic data structures and the abstract data structures and user defined data structures and their applications to represent various information types. Design and analysis of various algorithms for solving various searching, and sorting problems.
Course Outline:

Recommended Books:
3. Weiss, "Data structures and algorithm analysis in C++".

Electrical Engineering Foundation

Linear Circuit Analysis

Prerequisites: None

Objective: Introduce basic electrical engineering concepts and to acquaint students with the knowledge and the tools to analyze linear electric circuits.

Course Outline:
Electric quantities, electric signals, electric circuits, Kirchhoff’s laws, circuit elements. Resistance, series parallel combination, voltage and current dividers, resistive bridges and ladders, practical sources and loading, instrumentation and measurement. Nodal analysis, loop analysis, linearity and superposition, source transformation, one ports, circuit theorems, power calculations, dependent sources, circuit analysis with dependent sources, ideal transformer, amplifiers. The operational amplifier, basic op-amp configurations, ideal op-amp circuit analysis, summing and difference amplifiers, amplifier types. Capacitance, inductance, natural response of RC and RL circuits. Response to DC forcing function. Transient response of first order circuits, step, pulse and pulse train responses, first order op-amp circuits. Transient response and step response of second order circuits. AC fundamentals; RMS or effective, average and maximum values of current & voltage for sinusoidal signal wave forms.

Lab Work Outline:
Learn the use of basic instruments in electrical engineering such as function generators, power supplies, oscilloscopes. Design and implement circuits using R, RL and RC and verify the node voltages and loop currents using instruments. Verify Circuit-theorems using lab instruments. Verify circuit transformations using lab instruments.

Recommended Books:

**Workshop Practice**

**Prerequisites:** None

**Objective:** To develop practical skills in the use of workshop tools and equipment.

**Course Outline:**
Introduction to various technical facilities in the workshop including mechanical and electrical equipment. Concepts in electrical safety, safety regulations, earthing concepts, electric shocks and treatment. Use of tools used by electricians, wiring regulations, types of cables and electric accessories including switches, plugs, circuit breakers, fuses etc., symbols for electrical wiring schematics e.g. switches, lamps, sockets etc., drawing and practice in simple house wiring and testing methods, wiring schemes of two-way and three-way circuits and ringing circuits, voltage and current measurements. Electric soldering and soldering tools; soldering methods and skills, PCB designing, transferring a circuit to PCB, etching, drilling and soldering component on PCB testing.

**Recommended Books:**

**Electrical Network Analysis**

**Prerequisites:** Linear Circuit Analysis

**Objective:** To equip the students with the knowledge and techniques of analyzing electrical networks.

**Course Outline:**
Current and voltage transients, RLC circuits with DC and AC excitation, resonant circuit: series and parallel resonance in AC circuit, Q-Factor, mutual inductance and transformers, introduction to phasor representation of alternating voltage and current, single-phase circuit analysis, star-delta transformation for DC and AC circuits, poly-phase generators, sphase sequence, vector diagrams for balance and unbalanced three phase networks, power in three phase circuits and different methods of its measurements. Two-port networks and their interconnections. Application of Laplace transform in circuit analysis.

**Lab Work Outline:**
Design and implement RLC circuits and observe resonance and impedance characteristics. Verify the node voltages and loop currents in RLC circuits using
instruments. Verify Circuit-theorems using lab instruments. Verify circuit transformations using lab instruments. Learn the use of Circuit Simulation computer package such as SPICE. Observe transient and steady state response in RL, RC and RLC circuits using SPICE.

**Recommended Books:**

**Electronic Devices and Circuits**

**Prerequisites:** Linear Circuit Analysis

**Objective:** The objective of this course is to teach the principle, operation and characteristics of various electronic devices and their applications in electronic circuits.

**Course Outline:**
PN Junction, device physics, diode circuits, clampers and rectifiers. Zener diodes, LED, Llaser diode, photo diode, tunnel diode, BJTs, FETs and MOSFETS. Biasing circuits for BJT and FET. Small signal transistor models. Single transistor amplifiers. Operational amplifiers.

**Lab Work Outline:**
Observe electrical characteristics of Diodes, BJT and FET. Design, implementation and measurements of electronic circuits for rectifiers, zener diode regulators, Biasing in BJT and FET, Small-signal amplifiers in BJT and FET. Use of Operational amplifiers.

**Recommended Books:**
1. Behzad Razavi, "Fundamentals of Microelectronics".

**Digital Logic Design**

**Prerequisites:** None

**Objective:** To introduce the concepts for the design of digital electronic circuits and systems.

**Course Outline:**
Number Systems, Boolean Algebra, Logic Simplification, Combinational Logic, Sequential Logic, Tri-state logic, Counters, Shift Registers, Computer Buses,
Memory, Storage, Adders, Multiplexers and simple arithmetic logic unit (ALU) design.

**Lab Work Outline:**
Basic logic gates, hardware implementation of combinational logic circuits such as multiplexers and de-multiplexers, encoders/decoders, ALU; implementation of sequential circuits such as flip-flops, registers, shift registers, counters and other digital circuits.

**Recommended Books:**
2. Tocci and Widmer, "Digital Systems: Principles and Applications".

**Engineering Drawing**

**Prerequisites:** None

**Objective:** To equip the students with the basic knowledge and skills of engineering drawing and its application in practical scenarios. The students will also be introduced to a CAD package.

**Course Outline:**
Types of lines and usage, dimensioning, lettering, orthographic first angle projection, sheet planning, orthographic third angle projection, introduction to computer aided drawing, isometric projection, sectional drawing and assembly drawing. Drawing sheets will be prepared on drawing board as well as CAD package.

**Recommended Books:**
2. A. C. Parkinson, "First Year Engineering Drawing".

**Probability Methods in Engineering**

**Prerequisites:** Calculus and Analytical Geometry

**Objective:** To introduce the basic concepts and engineering applications of probability and statistics.

**Course Outline:**
Set theory, basic concepts of probability, conditional probability, independent events, Baye's Theorem, 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 and applications.

**Recommended Books:**
Microprocessor Systems

Prerequisites: Digital Logic Design

Objective: To acquaint the students with the organization, programming and applications of microprocessor-based systems.

Course Outline:
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.

Lab Work Outline:
Complete design and hardware implementation of microprocessor-based systems and connecting to peripherals. Programming of microprocessor-based systems and debugging using Assembly language and related tools.

Recommended Books:
3. Mazidi, "Programming, Interfacing and Design using 8086".

Signals and Systems

Prerequisites: Electrical Network Analysis, Complex Variables and Transforms

Objective: To provide understanding of signals, systems and transforms.

Course Outline:
Continuous time and discrete time signals, periodic signals, even and odd signals, exponential and sinusoidal signals, the unit impulse and unit step functions, continues time and discrete time systems, linear time invariant (LTI) systems, difference equation, 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, case studies: communication systems and linear feedback systems. Introduction to Analog filter design.

Lab Work Outline:
Develop and understanding of signal systems and transforms using MATLAB.

Recommended Books:
Electrical Engineering (Breadth)
Include Breadth Subjects of all Streams

Electromagnetic Field Theory

**Prerequisite:** Multivariable Calculus.

**Objectives:** Introduce the concepts and mathematical methods to understand and analyze electromagnetic fields and waves.

**Course Outline:**

**Recommended Books:**

Communications Systems

**Prerequisites:** Signals and Systems, Probability Methods in Engineering.

**Objective:** This course is structured as a senior-level design course emphasizing fundamental communication principles and the application of these principles to contemporary analogue and digital communication systems. Students learn basic concepts (both digital and analogue) associated with information, coding, modulation, detection, and signal processing in the presence of noise. They apply these concepts to the design of contemporary communications, and digital telephony such as television, radio, wireless, mobile, and satellite communications.

**Course Outline:**
Amplitude Modulation: Baseband and carrier communications, Double Sideband (DSB), Single Sideband (SSB), Vestigial Sideband (VSB), Superheterodyne AM Receiver, Carrier Acquisition, Television
Angle Modulation: Instantaneous frequency, Bandwidth of FM/PM, Generation of FM/PM, Demodulation of FM/PM.
Noise: Mathematical representation, Signal to Noise Ratio, Noise in AM, FM, and PM systems

**Recommended Books:**

**Electrical Machines**

**Prerequisites:** Linear Circuit Analysis

**Objectives:** Covers fundamental aspects of Electrical Machines.

**Course Outline:**

**Recommended Books:**

**Linear Control System**

**Pre-Requisites:** Signals and Systems

**Objective:** This course is aimed to build a comprehensive foundation in the analysis and design of control systems using classical and modern techniques.

**Course Outline:**
Recommended Books:

Power Distribution and Utilization

Prerequisite: Electrical Network Analysis

Objectives: Students are introduced to the basics of power distribution systems and effective utilization of power in heating and illumination applications.

Course Outline:

Recommended Books:

Instrumentation and Measurements

Prerequisite: Electrical Network Analysis, Digital Logic Design

Objective: Introduce the concepts and the methods and instruments for the measurement of electrical and non-electrical quantities.

Course Outline:
Precision measurements terminologies principles of different measurement techniques; instruments for measurement of electrical and non-electrical quantities; systems for signal processing and signal transmission; modern instrumentation techniques; static and dynamic responses of instrumentation and signal conditioning; data acquisition systems; principles of operation, construction and working of different analog and digital meters, Advanced Testing & Measuring instruments recording instruments, signal generators, Input and output transducers; types of bridges for measurement of resistance,
inductance, and capacitance; power and energy meters; high-voltage measurements.

**Lab Work Outline:**
Design, construction, and analysis of measurement circuits, data acquisition circuits, instrumentation devices, and automatic testing; measurement of electrical parameters using different lab instruments; calibration of measurement instruments; use of data acquisition systems for presentation and interpretation of data; use of microcomputers to acquire and process data; use of simulation and instrumentation languages (LabVIEW).

**Recommended Books:**

**Electronic Circuit Design**

**Prerequisite:** Electronic Devices & Circuits

**Objective:** Introduce DC and AC analysis and design of single stage, capacitor coupled and direct coupled amplifiers, classification and types of amplifiers, feedback and oscillators. BJT and FETs (MOSFETs) are covered.

**Course Outline:**

**Lab Outline:**
Characteristics and Analysis of BJTs, FET and MOSFETs. Multistage Amplifiers, Feedback in amplifiers, Oscillators.

**Recommended Books:**

**Computer Communication Networks**

**Prerequisites:** Communication Systems

**Objective:** To help the students gain an understanding of the terminology and standards in modern day computer networks. To make the students understand communication basics, networking and network technologies; with emphasis on data and computer communication within the framework of the OSI and TCP/IP protocol architectures, internet and internetworking and how to apply these in the design and analysis of networks.

**Course Outline:**
Network architectures and switching techniques, characteristics of transmission media. Channel access protocols and their efficiency. Link control protocols, and their efficiency. Routing algorithms and protocols. Interconnection of network at the link level and at the network level, the Internet Protocol (IP) and associated
control protocols. End-to-end protocols, with TCP and UDP as examples; congestion control and flow control. Cursory view of application-level protocols, including electronic mail, HTTP and DNS. Introduction to network calculus (Optional).

**Recommended Books:**

**Computer Architecture & Organization**

**Prerequisites:** Digital Logic Design

**Objective:** Upon completion of this course, the student will have basic understanding of computer system architecture including CPU design, memory subsystem design and performance enhancement techniques.

**Course Outline:**
Overview of main computer architectures and their performance comparison, instruction set architecture, CPU design, cache memory, different designs of cache memory system, virtual memory system, address mapping using pages, pipeling, super scaling, and threading, instruction level parallelism (ILP), introduction to parallel processing. Branch prediction, pre-fetching, multithreading.

**Recommended Book:**

**Software Engineering**

**Prerequisite:** Data Structures and Algorithms

**Objectives:** To understand, analyze and develop complex software by going through different phases of software engineering methodology.

**Course Outline:**
Introduction to software engineering, Models of the software development process, Software requirements and specifications, Project planning, organization and management, Software analysis and design techniques, Team project activities, Software quality assurance, Software testing, Software Engineering tools (CASE Tools) and environments.

**Recommended Books:**

**References:**
Operating Systems

Prerequisite: Data Structures and Algorithms

Objectives: To introduce various basic operational and management functions of an operating system.

Course Outline:

Recommended Books:

Database Management Systems

Prerequisite: Data Structures and Algorithms

Objectives: To introduce different data base design methodologies.

Course Outline:
User interface, data independence, user view, three data models (relational, hierarchical, network, object oriented), conceptual, logical and physical database design and evaluation, normalization, query languages, query optimization, security, integrity and concurrency protocols, introduction to SQL and its application to RDBMS. Database design, model building, data table, forms & reports. Database administration.

Lab: Laboratory work will be based on the contents of the course.

Recommended Books:
Include Elective Subjects of all Streams

Digital Communication

Prerequisites: Communication Systems

Objective: The objective of the course is to prepare students for engineering work and research in the telecommunication industry. The course covers concepts and useful tools for the design and performance analysis of a digital transmitter and receiver at the physical layer of a communication system.

Course Outline:
Significance of digital communication, overview of signals, spectra, probability and random variables, SNR and Eb/No, Sampling and quantization (uniform & non-uniform), Signal to quantization noise ratio (SQNR). Detection of a binary signal in Gaussian noise, Matched filters and correlators, Baye’s decision criterion, Maximum likelihood detector, Error performance, Inter-symbol interference (ISI), Root raised cosine pulse, Eye-patterns, Equalization techniques. Vectorial representation of signals, Gram-schmidt orthogonality principle, Performance analysis of M-ary signaling techniques. Error correcting codes: block codes, design and analysis of convolutional codes, Advanced techniques for digital communication (e.g. DS-CDMA, FH-CDMA, OFDM, MIMO techniques).

Recommended Books:

Optical Communication

Prerequisites: General Physics, Communication Systems

Objective: To acquaint the students with the devices and techniques used in optical fiber communication

Course Outline:
Comparison between optical and electrical mediums, basic optical communication system, Snell’s law, refractive index, line width, optical and electrical bandwidth. Step index fibre, graded index fiber, refractive index profiles, meridional and skew rays, acceptance angle and acceptance con, numerical aperture for meridional and skew rays. EM waves, modes, modes in
planar wave guides, wave guide condition, evanescent waves, phase velocity, group velocity, group index, modes in cylindrical fibres, Parameters for single mode fiber (cutoff wavelength, mode field diameter, effective refractive index, group delay). Attenuation due to: (i) absorption, (ii) scattering (iii) bending losses Dispersion, Reflectance and optical return losses, special types of fibers. Optical sources, modulators and modulating schemes, line coding, optical detectors, demodulator and demodulation methods, couplers, connectors, switches, splicing, optical amplifiers and repeaters, Optical time division multiplexing, wavelength division multiplexing (techniques and devices) link budgeting w.r.t time and power. LAN system, FDDI, SONETS and SDH, Wavelength routing based optical networks, Optical burst switching.

**Recommended Books:**

**Wireless and Mobile Communication**

**Prerequisites:** Communication Systems

**Objective:** To provide an overview of the fundamental concepts and technologies involved in wireless and mobile communication systems.

**Course Outline:**

**Recommended Books:**
3. William Stallings, "Wireless Communications & Networks by Pearson, Latest Ed

**Navigation and Radar Systems**

**Prerequisites:** Electromagnetic Field Theory

**Objective:** This course is intended to give an overview of optical fiber, optical fiber communication and different devices used in optical communication. Important theoretical and mathematical problems will be discussed to understand the in-depth functionality of optical networks.
Course Outline:

Recommended Books:

Satellite Engineering

Prerequisites: Communication Systems

Objective: The objective of this course is to get comprehensive knowledge of satellite technology and communication.

Course Outline:

Recommended Books:
Wave Propagation and Antennas

Prerequisites: Electromagnetic Field Theory

Objective: To make the students understand different aspects of electromagnetic wave propagation and the role of antenna as transducer. Different characteristics of antennas are also explained.

Course Outline:

Recommended Books:

Digital Signal Processing

Prerequisites: Signals and Systems

Objective: This course aims to develop mathematical and analytical skills necessary to analyze digital signals both in time and frequency domains. From the system’s perspective, the objective is to incorporate extensive design skills in the students enabling them to develop relevant prototypes with the desired level of accuracy.

Course Outline:

Recommended Books:
RF and Microwave Engineering

**Prerequisites:** Wave Propagation and Antennas

**Objective:** To introduce basic concepts of Radio Frequency (RF) components and circuits especially in the range of microwaves.

**Course Outline:**

**Recommended Book:**

Information Theory and Coding

**Prerequisites:** Communication Systems

**Objective:** The course aims at representing information in a format so that it is able to be transmitted successfully by removing/omitting any errors introduced by the channel.

**Course Outline:**
Information, Entropy, Relative & mutual Entropy, Chain rules for entropy and mutual information, Source coding, Data compression, Examples of compression codes, Huffman codes, Lempel-ziv codes, Types of channels: discrete memoryless, Binary Symmetric, Binary Erasure, Gaussian channel capacity, Shannon’s Theorem, Prefix and Block codes (fixed and variable length), binary fields and vectors spaces, linear block codes, Hamming codes, error rate, performance bounds, cyclic codes, polynomial representation, generation and decoding of cyclic codes, BCH codes, Reed-Solomon codes, convolutional codes, structural properties, Viterbi algorithm (Hard and soft decision decoding), concatenated codes, Turbo Codes, LDPC codes.

**Recommended Book:**

Mobile and Pervasive Computing

**Prerequisites:** Wireless and Mobile Communication

**Objective:** The aim of this module is to make students aware with the technologies and modern trends in computing and telecom industry. The main objectives of this module are to learn the advancements of cellular networks & mobile computing devices to understand pervasive & ubiquitous computing.
Course Outline:

Recommended Books:

Transmission and Switching

Prerequisites: Computer Communication Networks

Objective: The course has been designed to equip the students with skills and knowledge of the current and future telecommunication networks.

Course Outline:
Recommended Books:
1. J. E. Flood, "Telecommunication Switching, Traffic and Networks".
2. Bellamy, "Digital Telephony".

Multimedia Communication

Prerequisite: Communication Systems

Objective: To develop familiarity with the science and technology of multimedia communication.

Course Outline:
Overview of multimedia systems, Audio/Video fundamentals (representation, human perception, equipment and applications). Audio and video compression (e.g., JPEG, MPEG, H.26X, etc.), scalable coding, perceptual audio encoders. Performance comparison of coding algorithms, Algorithms for image and video processing, multimedia programming.

Recommended Books:

Power System Analysis

Prerequisite: Electrical Network Analysis, Power Distribution and Utilization

Objectives: This course has been designed to introduce the importance of analyzing various aspects of power system. It covers power flow studies and fault analysis of both symmetrical and unsymmetrical faults in power networks. This forms the basis for power system operation, control and protection.

Course Outline:
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 Δ circuits; power in terms of symmetrical components; sequence networks of Y and Δ impedances; sequence networks of a symmetrical Transmission line; sequence Networks of the synchronous Machines; Sequence Networks of Y-Δ 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.

**Recommended Books:**

**Power Generation**

**Prerequisite:** Power Distribution and Utilization

**Objectives:** The students learn different power plant and modes of energy conversion to generate electrical energy in this course and the concepts of fuel cells are introduced.

**Course Outline:**
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 turbines and their stations. 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 grays neutrons, materials for construction. Thermoelectric Generators: Thermoelectric effect, solid state description of thermoelectric effect, analysis and design of thermoelectric generators, 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 PN 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. Wind power generation.

**Recommended Books:**
Advanced Electrical Machine Design

**Prerequisite:** Electrical Machines

**Objectives:** Discussion of design and loading of Power Transformers and Induction motors is introduced and electrical equipment installation; commissioning, testing and troubleshooting practices are discussed.

**Course Outline:**
**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 Troubleshooting of Machines:** Safety precautions, troubleshooting and emergency repairs. Installation, commissioning, testing, maintenance, and troubleshooting of (i) power transformers 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 the following equipment: power supplies, magnetic contactors, thermal overloads, miniature circuit breakers, metallic-clad circuit breakers, earth leakage circuit breaker, clip-on meters, cable fault locators, Megger earth tester, relay testers, motor controllers, tachometers, phase tester (L.V. and H.V.). 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.

**Recommended Books:**

Power System Protection

**Prerequisite:** Power Distribution and Utilization

**Objectives:** The course presents different types of relays, relaying schemes, circuit breakers and fuses. Topics like discrimination and coordination are also introduced.

**Course Outline:**
Introduction to protection system, types of faults, effect of faults, fuse as protective device, types of fuses, characteristics of fuses, selection and application of fuses, discrimination and coordination, current transformer and its operation, relay construction, basic relay terminology, electromagnetic relays, thermal relays, static relays and introduction to microprocessor based protective relays, over current protection, distance protection, impedance relay, R-X...
Recommended Books:

Power System Stability and Control

Prerequisite: Power Distribution and Utilization

Objectives: Different aspects of power system operation, monitoring and control are covered with an emphasis on SCADA systems.

Course Outline:
Steady state and transient stability problems of multi-machine interconnected systems, Swing equation, point-by-point solution of swing equation. Equal area criterion, One machine and two-machine systems, Critical fault clearing time. Effect of fault on stability, Stability study of typical Power systems. Introduction to power system control and its importance, modes of power system operation, major tasks of operation. SCADA system, control centres, controller tuning, communication sub system, remote terminal unit, data logging. Economic dispatch, characteristics of power generation units, economic dispatch problems with and without consideration of losses, incremental fuel cost, penalty factor, economic power interchange. Voltage, power and frequency control. Evaluation of the effect of speed change on droop characteristics.

Recommended Books:

Electrical Power Transmission

Prerequisite: Power Distribution and Utilization

Objectives: The course presents basics of electrical power transmission along with electrical and mechanical design impacts on power transmission in detail and HVDC transmission is introduced.

Course Outline:
Percent and per-unit quantities, selection of base and change in base of per unit quantities, node equations, one-line diagram, 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. 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 single phase and three-phase lines, effect of earth on capacitance, capacitance of bundled conductors, parallel circuit lines, Ferranti effect. 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. 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. Insulator material, types of insulators, voltage distribution over insulator string, string efficiency, methods of improving the string efficiency, testing of insulators, corona effect, corona loss, radio interference due to corona. Underground cables: types, 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. Introduction and classification of HVDC transmission.

**Recommended Books:**

**Advanced Electrical Machines**

**Prerequisites:** Electrical Machines

**Objectives:** Covers detailed and in depth aspects of Electrical Machines.

**Course Outline:**

**Lab Outline:** Based on above course contents

**Recommended Books:**
Power Electronics

Prerequisite: Electronic Circuit Design

Objectives: The course discusses Power Devices, Power Rectifiers, Power Inverters and Choppers in detail.

Course Outline: Principles of power electronics, converters and applications, circuit components and their effects, control aspects. Power Electronic Devices: Power diode, power BJT, power MOSFET, IGBT and SCR, GTO and TRIAC and DIAC. Construction, characteristics, operations, losses, ratings, control and protection of thyristors. Halfwave and full-wave rectifiers with resistive and inductive loads, un-controlled, semi controlled and fully controlled rectifiers, three-phase rectifiers: un-controlled, semi controlled and full controlled, six-pulse, twelve-pulse and 24-pulse rectification, PWM converters, DC to AC converters, three-phase inverter, six-pulse, twelve-pulse inverters, PWM inverters, switching mode power supplies, DC to DC conversion, buck converter, boost converter and buck-boost converters, isolated converters, forward converters, flyback converters.

Recommended Books:

Artificial Neural Networks

Prerequisites: Programming Fundamentals

Objective: To understand the concepts of neural technology, learning algorithms and training and using them to solve complex classification and recognition problems.


Recommended Books:

Digital Image Processing

Prerequisites: Programming Fundamentals, Signals and Systems

Objective: To understand the concepts of digital image acquisition, perception and processing in order to use them in computer vision, image enhancement and compression.

Course Outline:

Lab Outline:

Recommended Book:
1. R. C. Gonzales & Woods, "Digital Image Processing".

Data Warehousing & Data Mining

Prerequisite: Database Management Systems

Objectives: To have an understanding of the foundations, the design, the maintenance, the evolution, and the use of data warehouses. To master the basic range of techniques for creating, controlling, and navigating dimensional business databases. To have an understanding of the data mining process, its applicability, advantages and pitfalls.
Course Outline:
Introduction to Data Warehousing, Planning and Requirements, Logical & Physical Data Modeling, Denormalization & Dimensional Modeling, Data Extraction, Transformation and Loading, Online Analytical Processing (OLAP) Implementation Technique, Data Warehousing and the Web, Data Mining

Recommended Books:
3. Jiawei Han & Kamber M., Data Mining: Concepts & Techniques, 2nd Ed, 2006, Morgan Kaufman Publisher.

Software Project Management:

Prerequisites: Software Engineering

Objectives: Metrics based evolution of project, Role of project management during the project lineup

Course Outline:
Introduction to project management. Principals of project management, integrated software engineering project Planning (Project infrastructure, characteristics, Activities (Work Breakdown Structure), Iterative planning, Size, resource, cost and schedule estimation). Project Activity Planning (Network), Resource Requirements, Scheduling, and Allocation, Monitoring and Controlling Progress, Project organization and staffing, Risk analysis and management; Client Management, Project direction and control, Project progress visibility: matrices and measurement. Configuration Management.

Recommended Books:

Software Quality Assurance:

Prerequisite: Software Engineering

Objectives: Choose and apply appropriate quality control systems, standards, practices, and processes. Conduct effective inspections, reviews and audits. Understand CMM concepts and methods, and able to evaluate the current software engineering maturity by using external certifications to enhance existing practices. Know the basics of ISO process and standards, and know how to implement an effective quality measurement approach based on well-defined quality metrics and reporting formats. Understanding of Software testing
technique. Develop a good quality assurance plan and standards for large, small and fast-track projects. Understand how to use quality management tools effective.

**Course Outline:**

**Recommended Books:**

**Object Oriented Programming**

**Prerequisites:** Programming Fundamentals

**Objectives:** to introduce objects, class hierarchy, operations on objects and use them in solving real life problems.

**Course Outline:**
Procedural versus object oriented programming languages, UML modeling, object oriented design strategy and problem solving, objects and classes, member functions, public and private members, dynamic memory management, constructors and destructors, templates, object encapsulation, derived classes, class hierarchies, inheritance and polymorphism, operator overloading, stream class, practical design through Object Oriented Programming

**Recommended Books:**

**Digital System Design**

**Prerequisites:** Computer Architecture and Organization

**Objective:** To introduce the skills to write VHDL/Verilog code that can be synthesized to efficient logic circuits.

**Course Outline:**
High-level digital design methodology using VHDL/Verilog, Design, Implementation, and Verification, Application requiring HW implementation, Floating-Point to Fixed-Point Conversion, Architectures for Basic Building Blocks, Adder, Compression Trees, and Multipliers, Transformation for high

**Recommended Books:**

**Integrated Electronics**

**Prerequisites:** Electronic Circuit Design

**Objective:** Teach the analysis and design of digital electronic circuits and operational amplifier, and introduce the fabrication of electronic devices.

**Course Outline:**
Detailed design of pulse and switching circuits; mono-stable, a-stable and bi-stable circuits; Schmitt trigger; logic families (DTL, TTL, ECL, I2L, CMOS); 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; amplifier; linear and non-linear applications. analogue and digital circuit interface with applications;

**Lab Outline:**
Comparator analysis, inverting and non-inverting amplifiers, analog-to digital and digital-to-analog converters, dual regulator, switched capacitor voltage converter, op-amp DC characteristic measurement, op-amp speed, single-supply op-amp, function generator, phase locked-loop, frequency synthesizer.

**Recommended Books:**

**Opto-Electronics**

**Prerequisite:** General Physics

**Objective:** Teach the electronic devices and techniques used in optical communication.
**Course Outline:**
Nature of light, basic laws of light, optical fibre, types of optical fiber, fibre material, fabrication and components, laser, threshold condition, laser losses, population inversion and threshold conditions, laser modes, classes of lasers, semiconductor light sources, light emitting diodes, semiconductor laser diodes (SLDs), optical transmitter, optical receivers, wavelength division multiplexing (WDM), FDM versus WDM, WDM multiplexer, benefits of WDM, dense wavelength division multiplexing, optical networks.

**Lab Outline:**
Optical sources, optical detectors, optical amplifiers, optical transmitters, optical receivers, optical transceivers, optical fibers, propagation of light through an optical fiber, losses in fiber optic elements, optical modulation, multiplexing, optical systems.

**Recommended Books:**

**FPGA-Based System Design**

**Prerequisite:** Digital Logic Design

**Objective:** Teach the design of digital electronic circuits with field programmable gate arrays.

**Course Outline:**
Introduction to digital design and FPGA, FPGA architectures, SRAM-based FPGAs, permanently-programmed FPGAs, circuit FPGA-based system design, logic design process, combinational network delay, power and energy optimization, arithmetic logic elements, logic implementation using FPGAs, FSM design, ASM design. Physical design (PnR) for FPGAs, synthesis process. Sequential design using FPGAs, sequential machine design process, sequential design style.

**Lab Outline:**
Introduction to Verilog HDL, gate-level modeling, data flow modeling, behavioural modelling, design, simulation, synthesis and fitting of combinational circuits, design and implementation of an FSM and memory.

**Recommended Books:**

VLSI Design

Prerequisite: Integrated Electronics

Objective: Teach VLSI system design including system specification, verification, and fabrication.

Course Outline:
Introduction to integrated circuits, IC fabrication, monolithic integrated circuits, introduction to MOS technology, basic electrical properties of MOS and BiCMOS circuits, basic digital building blocks using MOS transistor basic circuit concepts, ultra-fast VLSI circuits and systems and their design.

Lab Outline:
Implementation of VLSI design techniques using VHDL and/or Verilog HDL.

Recommended Book:

Embedded System Design

Prerequisite: Programming Fundamentals, Digital Logic Design

Objective: Introduce the trends and challenges in the design of embedded systems and teach chip technologies and design tools needed for these systems.

Course Outline:
Trends and challenges in embedded system design, The Microcontroller Architecture, Assembly Language programming, Addressing modes and Instruction Set, I/O Ports programming, TIMER and SERIAL and PARALLEL port programming, Interrupts, interfacing, A/D and D/A conversion. Interfacing and Application using PWM.

Lab Outline:
Understanding and implementation of Micro controllers. A/D and D/A interfacing, Interfacing such as with LED/ LCD and KEYBOARD, etc. Speed control of DC Motor and stepper motor using PWM

Recommended Book:
Industrial Electronics

Prerequisite: Power Electronics

Objective: Teach various industrial applications of electronics including heating, welding, speed control of electrical machines, photo-electric devices, x-ray, PLCs, and data acquisition.

Course Outline:

Lab Outline:
Experiments related to the service and manufacturing automation using PLCs; speed control of DC, AC, and servo motors;

Recommended Books:

Digital Control Systems

Prerequisite: Control Systems

Objective: Teach the theory and methods for the analysis and design of digital control systems including theory of sampling, discrete transfer functions, z transform analysis, and stability.

Course Outline:
Basics of digital control, theory of sampling, sampled data systems, discrete signals and sampling, difference equation, discrete transfer functions, z transform analysis, frequency response methods, state equations, time-discrete representation of time-continuous systems, discrete control algorithms, design methods of digital controllers, stability of digital control systems, discrete equivalents for continuous controllers, pulse transfer functions of feedback systems, digital-to-analog conversion, digital filtering of systems.

Lab Outline:
Control system identification; controller design, experimentation, computer simulation, and analysis of control systems. All experiments are conducted with real-time process interface cards of PC for experimental data display and storage. Stored files are analyzed further using MATLAB. Lab assignments include computer-based control system simulation and design using MATLAB.
Recommended Books:

Introduction to Nanotechnology

Prerequisite: General Physics

Objective: The course goal is to discuss interesting emerging nanotechnologies by providing interdisciplinary scientific and engineering knowledge necessary to understand fundamental physical differences at the nanoscale.

Course Outline:
Introduction, nanoscale phenomena, nanoparticles, carbon nanostructures, nanowires, nanostructured materials, self assembly, surface probe microscopy, other nanoscale characterization, nanolithography, nanoscale devices and systems, applications of nanotechnology.

Recommended Books:
COMPULSORY COURSES

ENGLISH

Functional English

Objectives: Enhance language skills and develop critical thinking.

Course Contents:

Comprehension: Answers to questions on a given text. Discussion: General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students).

Listening: To be improved by showing documentaries/films carefully selected by subject teachers. Translation skills: Urdu to English. Paragraph writing: Topics to be chosen at the discretion of the teacher. Presentation skills.

Recommended Books:

Communication Skills

Objectives: Enable the students to meet their real life communication needs.

Course Contents:
Business communications; planning messages, writing concise but with impact. Letter formats, mechanics of business, letter writing, letters, memo and applications, summaries, proposals, writing resumes, styles and formats, oral communications, verbal and non-verbal communication, conducting meetings, small group communication, taking minutes. Presentation skills; presentation strategies, defining the objective, scope and audience of the presentation, material gathering material organization strategies, time management, opening and concluding, use of audio-visual aids, delivery and presentation.

Recommended Books:
5. Reading and Study Skills by John Langan

Technical Writing and Presentation Skills

Objectives: Enhance language skills and develop critical thinking

Course Outline:

Recommended Books:
4. The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

PAKISTAN STUDIES

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 Outline:

Historical Perspective
a) Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
b) Factors leading to Muslim separatism
c) People and Land
  i. Indus Civilization
  ii. Muslim advent
  iii. Location and geo-physical features.

Government and Politics in Pakistan
Political and constitutional phases:
 a) 1947-58
 b) 1958-71
 c) 1971-77
Contemporary Pakistan
a) Economic institutions and issues
b) Society and social structure
c) Ethnicity
d) Foreign policy of Pakistan and challenges
e) Futuristic outlook of Pakistan

Recommended Books:

SUGGESTED COURSES IN SOCIAL SCIENCES

Sociology and Development

Objectives: The main objective of this course is to apprise potential engineers about social factors that contribute towards enhancing their professional performance for the good of society and the country. This course is culture specific and has to be taught within the context of local and national socio-economic environment. The engineers are expected to supervise several people in different capacities and their understanding about human behaviour is critical for their optimum performance. Modification of human behaviour or getting work done from subordinates and seniors remain a major challenge for all the professional engineers. This course will enhance understanding about the
determinants of human behaviour, which ultimately will result in improved individual efficiency.

**Course Outline:**

**Recommended Books:**

**Social Anthropology**

**Objectives:** The students are expected to learn anthropological skills for application by professional engineers and other related practitioners. Societal growth needs are to be understood within our own cultural environment. Such a body of applied knowledge will result in improving the professional performance of would-be engineers. As culture and society play an important role towards all human activities, this course will help students relate technical skills to the societal needs and requirements.

**Course Outline:**

**Recommended Books:**
Understanding Psychology and Human Behaviour

Course Outline:


Recommended Books:

Professional Psychology

Course Outline:

Recommended Books:

Organizational Behaviour

Course Outline:

Recommended Books:
Introduction to Sociology

Course Outline:

Recommended Books:

Critical Thinking

Course Outline:

Recommended Books:

Introduction to Philosophy

Course Outline:
Definition and nature of philosophy. Theory of knowledge; Opinion and knowledge; Plato; the republic selection; Knowledge through reason; Descartes meditation on first philosophy; Knowledge through experience; Human Inquiry concerning human understanding (Selection); Experience structured by the mind; Kant critique of pure reason (Selection); Knowing and doing; James pragmatism (Selection); Knowledge and emotion; Jaggar love and knowledge (Selection).


Recommended Books:

SUGGESTED COURSES IN MANAGEMENT SCIENCES

Entrepreneurship

Objective: Entrepreneurship is an important component in the process of economic development. The purpose of this course is to analyse the theories of entrepreneurship and to go for case studies of successful entrepreneurs.

Course Contents:
Introduction: The concept of entrepreneurship, The economist view of entrepreneurship, The sociologist view, Behavioural approach, Entrepreneurship and Management.
The Practice of Entrepreneurship: The process of entrepreneurship, Entrepreneurial Management, The entrepreneurial business, Entrepreneurship in service institutions, The new venture
Entrepreneurship and Innovation: The innovation concepts, Importance of innovation for entrepreneurship, Sources of innovative opportunities, The innovation process, Risks involved in innovation
Developing Entrepreneur: Entrepreneurial profile, Trait approach to understanding entrepreneurship, Factors influencing entrepreneurship, The environment, Socio cultural factors, Support systems
Entrepreneurship Organization: Team work, Networking organization, Motivation and compensation, Value system
Entrepreneurship and SMES: Defining SMEs, Scope of SMEs, Entrepreneurial, managers of SME, Financial and marketing problems of SMEs
Entrepreneurial Marketing: Framework for developing entrepreneurial marketing, Devising entrepreneurial marketing plan, Entrepreneurial marketing strategies, Product quality and design
Entrepreneurship and Economic Development: Role of entrepreneur in the economic development generation of services, Employment creation and training, Ideas, knowledge and skill development, The Japanese experience
Case Studies of Successful Entrepreneurs
Recommended Books:
1. Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship
2. P.N. Singh: Entrepreneurship for Economic Growth
3. Peter F. Drucker: Innovation and Entrepreneurship
4. John B. Miner: Entrepreneurial Success

Principles of Management

Objectives: This is a rudimentary course for the students of business administration. The focus of attention will be given to learning fundamental principles of management and of managing people and organization in a historical as well as contemporary world. Students are expected to develop analytical and conceptual framework of how people are managed in small, medium and large public and private national and international organizations.

Course Contents:

Recommended Books:
1. Stephen P. Robins, Mary Coulter: Management
2. H. Koontz Odonnel and H. Weihrich: Management
3. Mc Farland: Management: Foundation and Practice
4. Robert M. Fulmer: The New Management

ISLAMIC STUDIES

Objectives:
The objectives of this course are:
✓ 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 Outline:
Introduction to Quranic studies:
✓ Basic Concepts of Quran. History of Quran. Uloom-ul-Quran
Study of selected text from the Quran:
✓ Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
✓ Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
✓ Verses of Surah Al-Mumanoon Related to Characteristics of the faithful (Verse No-1-11)
✓ Verses of Surah al-Furqan Related to Social Ethics (Verse No. 63-77)
✓ Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)
Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No. 6, 21, 40, 56, 57, 58.)
Verses of Surah Al-Hashar (18, 19, 20) Related to thinking, Day of Judgment
Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No. 1, 14)
Seerat of Prophet (SAW) I:
Life of Muhammad Bin Abdullah (Before Prophet Hood)
Life of Holy Prophet (SAW) in Makkah
Important Lessons Derived from the life of Holy Prophet in Makkah
Seerat of Prophet (SAW) II:
Life of Holy Prophet (SAW) in Madina
Important Events of Life Holy Prophet in Madina
Important Lessons Derived from the life of Holy Prophet in Madina
Introduction to Sunnah:
Introduction to Islamic law & Jurisprudence:
Islamic Culture & Civilization:
Islam and Science:
Islamic Economic System
Political System of Islam
Basic Concepts of Islamic Political System. Islamic Concept of Sovereignty. Basic Institutions of Govt. in Islam.
Islamic History
Social system of Islam

Reference 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”
5. Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)
The proposed list of subjects for MEng/MSc/ME programmes in Electrical Engineering in different specializations is given below. This list is not exhaustive. Individual universities/ institutions may design specializations and subjects keeping in view the demand and availability of faculty and facilities. The curriculum/ syllabus shall be approved by the individual university/ institution as per procedures listed in their charters.

**Power Systems Engineering**
1. Advanced High Voltage Engineering
2. Power System Circuit Breakers and Sub stations
3. Power System Modeling and Analysis
4. Advanced Power System Transmission
5. Power System Distribution
6. Power System Reliability
7. Advanced Power System Protection
8. Insulation Coordination in Power Systems
9. Power Generation Economics
10. Power System Restructuring
11. Energy Management
12. Advanced Power System Stability
13. Power Quality
15. Distributed Generation
16. Condition Monitoring Techniques
17. Control of DC Machines and Drives
18. Control of AC Machines and Drives
19. Power Electronics Devices and Converters
20. Modeling and Simulation of Converters
21. Switch-Mode Power Supplies
22. Modeling and Simulation of Electrical Machines
23. Special Electrical Machines
25. Advanced Control Systems

**Control Systems Theory**
1. Linear Control Systems
2. Non-Linear Control Systems
3. Linear Multivariable Control Theory
4. Control System Optimization
5. Optimal Control Systems
6. Random Variables and Stochastic Processes
7. Stochastic Processes in Electrical Engineering
8. Estimation Theory
9. Adaptive Control Systems
10. Stochastic Control
11. Digital Control Systems
12. Dynamics of Robots
13. Introduction to Chaos Theory
14. Chaos Theory & Fractals
Telecommunication
1. Probability and Random Processes
2. Advanced Communication Systems
3. Advanced Digital Communication
4. Information Theory and Coding
5. Advanced Communication Networks
6. Microwave Systems
7. Advanced concepts in Radar Applications
8. Global Positioning and Navigation Systems
9. Advanced Digital Signal Processing
10. Advanced Mobile Communication
11. Signal Detection and Estimation
12. Advanced Optical Communication
13. Advanced Satellite Communications
14. Radio wave Propagation
15. Broadband Communication
16. Electromagnetic Propagation
17. Multimedia Communication
18. Cryptography and Security
19. Signal Processing Applications in Reconfigurable Architecture
20. Stochastic Processes
21. Modelling and Simulation
22. Telecommunication Network Operations

Communication Systems and Networks
1. Electromagnetic Field Analysis
2. Semiconductor Device Physics
3. Linear Control Systems
4. Advanced DSP
5. Stochastic Systems
6. Radiating Systems & Antennas
7. Microwave Networks & Passive Components
8. Microwave Devices
9. Advanced Computer Networks
10. Detection & Estimation
11. Adaptive Filter Theory
12. Secure Communications
13. Advanced Digital Communication
14. Computational EM
15. Microwave IC Design
16. Real-time DSP
17. Spatial Array Processing
18. Filtering & Tracking
19. Information & Coding Theory
20. Wireless Communication
21. Digital Integrated Circuit Design

Electronics and Embedded Systems
1. Semiconductor Device Physics
2. Semiconductor Processing
3. Linear Control Systems
4. Electromagnetic Field Analysis
5. Stochastic Systems
6. Quantum Mechanics
7. Microwave Devices
8. Solid State Electronics
9. Non-Linear Control Systems
10. Thin Film Processing
11. Radiating Systems & Antennas
12. Photonic Devices
13. Thin Film Characterization
14. Computational E.M.

Control and Automation Engineering
1. Linear Control Systems
2. Stochastic Systems
3. Digital Control
4. Non-linear Control Systems
5. Optimal Multivariable Control
6. Robust Control
7. System Identification
8. Adaptive Filter Theory
9. Detection & Estimation
10. Filtering & Tracking
11. Adaptive Control Systems
12. Fuzzy Control
13. Digital Integrated Circuit Design
Final Recommendations of the NCRC for B.Sc/BE/BS Programme

- The purpose of this curriculum is to provide a uniform guideline to universities and institutions in Pakistan while developing their curriculum with an effort to have uniformity of standards in their programmes.

- The curriculum committee used the HEC Curriculum template as the fundamental working document for engineering discipline. This template is also mandated by Pakistan Engineering Council (PEC). It breaks up the curriculum into engineering content and non-engineering content with the former covering between 65 - 70% of the curriculum and the later covering 35 - 30% of the remaining curriculum. Mathematics with the exception of Probability and Statistics has been included in the non-engineering content. The engineering content is further broken up into Interdisciplinary engineering electives (IDEE), Computing essentials, Foundation, Breadth (Core) and Depth (Core and Electives).

- The committee decided that since a uniform curriculum is being developed with a nomenclature of Electrical Engineering, the non-engineering content, Computing essentials, IDEE and the Foundation would be identical. It was decided by the committee to classify IDEE as subjects from PEC accredited engineering disciplines other than Electrical Engineering such as Civil Engineering, Mechanical Engineering, etc.

- Also, it was decided that the credit hours in the proposed curriculum scheme would remain within the limits of 130 - 138 as decided by HEC for undergraduate curriculum.

- The committee recommends that a reasonable departure in contents from the contents of proposed curriculum may be expected by accrediting bodies like Pakistan Engineering Council. The term reasonable may be decided by the Visitation team on merit and experience in consultation with the concerned university's officials. The committee also noted that the titles of a certain set of contents (subjects) offered by universities may differ from the titles proposed by this committee. Universities may break up contents or combine portions of contents as per their own peculiar requirements.

- As it is apparent from the designed curriculum of Electrical Engineering and its four variants, the curriculum foundation is the same for all, only Computer (Systems) Engineering has the maximum departure in breadth electives, whereas the other three streams have significant commonality even in breadth electives.

- Universities/ Institutions offering Electrical Engineering program as such have a wide variety of electives at their disposal spanning all subjects being offered in all variants. Universities/ Institutions offering separate programmes in any of the variants (streams) may use the specific stream template relevant to their programme.

- Since Computer (Systems) engineering has the maximum departure in the overall curriculum content, it may be treated as a separate discipline altogether, closely associated with Electrical Engineering as practiced at
numerous international universities for the purpose of curriculum development.

- Since a unified framework is being proposed, it is strongly suggested that eligibility criterion for admission into undergraduate programs in Electrical Engineering may also be revisited. For example, Chemistry is mandatory at intermediate level for induction into Electrical Engineering and Electronic Engineering, whereas this is not mandatory in Computer (Systems) Engineering and Telecommunication engineering. In case, eligibility requirement is relaxed by making Chemistry optional, then Chemistry as an additional course will have to be taught to students who have not studied it at the intermediate level.

**Recommendations of the NCRC for Master Programme in Electrical Engineering**

Due to the variation in expertise and facilities available in different universities of Pakistan, NCRC recommended a flexible type of Master’s Degree program. Their recommendations follow:

(a) For award of Masters degree, candidates will either need to complete 30 credit hours of course work or complete 24 credit hours of course work along with a minimum of 6 credit hours for research work/thesis. For universities not following Semester System, the requirement is 8 courses plus thesis or ten courses with each course having a theory contact for at least three hours per week during the term.

(b) The course titles of the MS/ME in Electrical Engineering with specialization in Power Engineering, Communication/ Telecommunication Engineering, Electrical Machines and Power Electronics, Control Systems, Computer Engineering, and have been outlined. Other specializations may be added as required by each university offering the Masters programme keeping in view the availability of resources. The details of course contents, structure, and requirement of programmes is the responsibility of the individual university according to faculty availability, suitability and needs.