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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PREFACE

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).

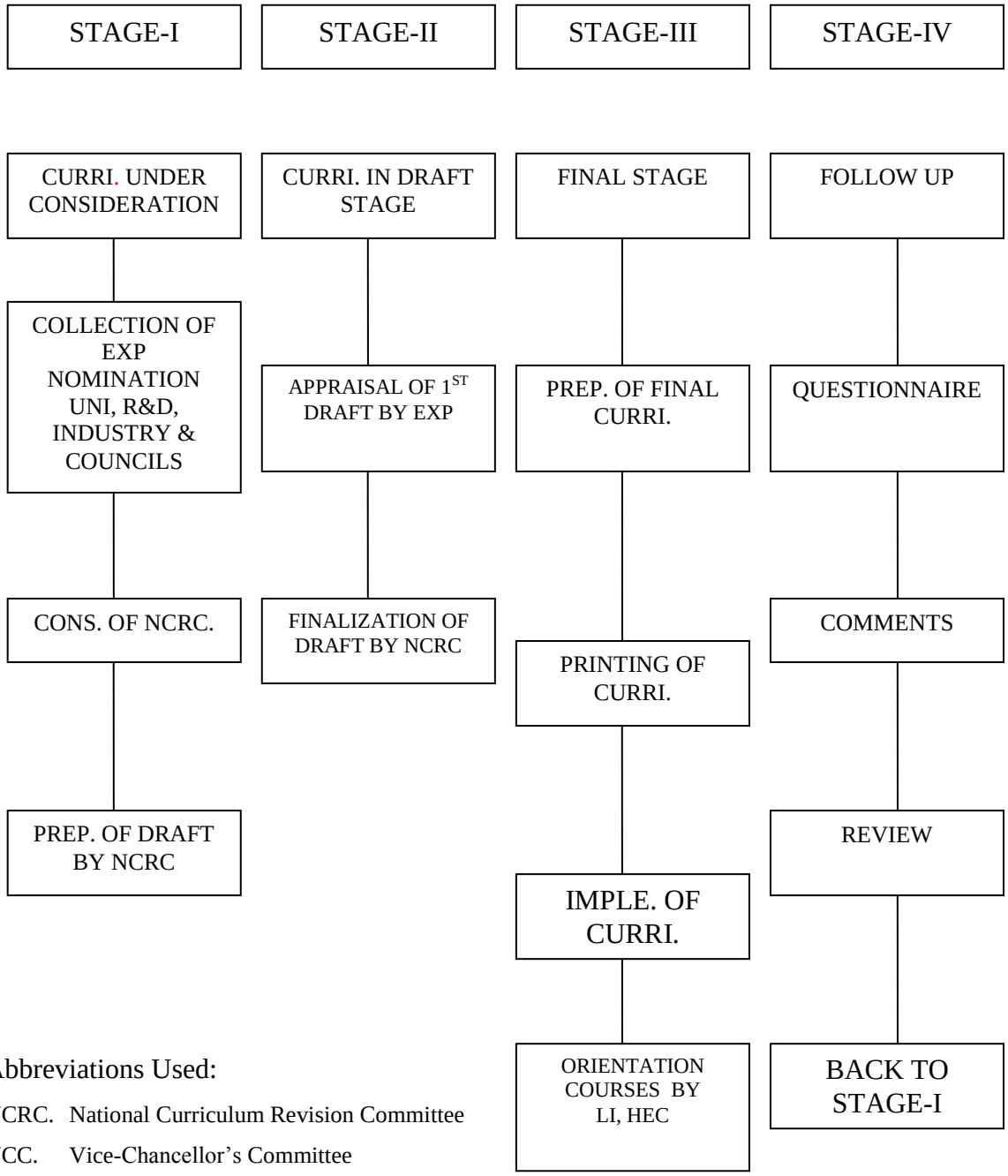
A committee of experts comprising of conveners from the National Curriculum Revision Committees of HEC in the disciplines of Basic, Applied, Social Sciences, Agriculture and Engineering met in 2007 & 2009 and developed the unified templates to standardize degree programmes in the country so as to bring 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



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, Member
Head of Electrical Engineering Department,
College of Engineering & Sciences,
Institute of Business Management,
Korangi Creek Road, Karachi.

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

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

10. Dr. Syed Muhammad Atif Saleem, Member
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, Member
Associate Professor, Department of Electronics,
PAF-Karachi Institute of Economics and Technology
(PAF-KIET),
Korangi Creek, Karachi – 75190.

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

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

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

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

16. Dr. Arshad Hussain, Member
Professor, Department of Electrical Engineering,
National University of Computer & Emerging Sciences

(NUCES),
Lahore Campus, Block B, Faisal Town,
Lahore.

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

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

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

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

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

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

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

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

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

26. Prof. Dr. A. H. S Bukhari, Member
Professor / Dean, Department of Electronic Engineering,

Balochistan University of Information Technology,
Engineering & Management Sciences,
Quetta.

27. Prof. Dr. Muhammad Akram Shaikh, — Member
Professor,
Department of Computer Systems and Software Engineering,
Mehran University of Engineering & Technology,
Jamshoro.

28. Engr. Prof. Dr. Muhammad Yunus Javed, — Member
Nominee Pakistan Engineering Council (PEC),
College of Electrical & Mechanical Engineering,
NUST, Islamabad.

29. Prof. Dr. Jameel Ahmed, — Member
Professor and Chairman, Department of Electrical Engineering,
Hitec University, Taxila Cantt.

30. Prof. Dr. Tahir Izhar, — Member
Electrical Engineering Department,
University of Engineering & Technology,
Lahore

31. Dr. Muhammad Bilal Malik, — Member
Associate Professor, Head of Department (Electrical Engineering),
College of Electrical & Mechanical Engineering,
Rawalpindi.

32. Dr. Syed Izhar Hussain Zaidi, — Member
SUPARCO, Karachi

33. Engr. Niaz Ahmed Kheskheli, — Member
Deputy Registrar (Accr.)
Pakistan Engineering Council (PEC),
Islamabad.

34. Engr. Samreen Amir, — Member
Coordinator Industrial Interaction Program & Assistant Professor,
Room No. GG-01,
Sir Syed University of Engineering & Technology,
Karachi.

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 text books. 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
9. Engr. Ms. Samreen Amir
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
9. Engr. Ms. Samreen Amir

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

Knowledge Area	Sub Area	Name of Course	Theory Contact Hours	Practical Contact Hours	Credit Hours (CH)	Number of Subjects	Total Credit Hours
Humanities	English	Functional English	3	0	3	3	9
		Communication Skills	3	0	3		
		Technical Writing	3	0	3		
	Culture	Islamic Studies / Ethics	2	0	2	2	4
		Pakistan Studies	2	0	2		
	Social Sciences	Social Sciences-I / Any Foreign Language	3	0	3	2	6
		Social Sciences-II	3	0	3		
Management Sciences	--	Professional Practice (or any other Management Course)	3	0	3	2	6
		Engineering Economics & Management	3	0	3		
Natural Sciences	Math	Calculus & Analytical Geometry	3	0	3	3	9
		Linear Algebra	3	0	3		
		Differential Equations	3	0	3		
	Physics	Applied Physics	3	3	4	1	4
	Electives	Elective I*	3	0	3	2	6 to 7
		Elective II*	3	0/3	3/4		
Total						15	44 to 45

* 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

Knowledge Area	Name of Course	Theory Contact Hours	Practical Contact Hours	Credit Hours (CH)	Number of Subjects	Total Credit Hours
Computing	Introduction to Computing	1	3	2	3	9
	Programming Fundamentals	2	3	3		
	Data Structures and Algorithms	3	3	4		
Electrical Engineering Foundation	Linear Circuit Analysis	3	3	4	9	29
	Electrical Network Analysis	3	3	4		
	Workshop Practice	0	3	1		
	Signals and Systems	3	3	4		
	Electronic Devices & Circuits	3	3	4		
	Digital Logic Design	3	3	4		
	Microprocessor Systems	3	3	4		
	Probability Methods in Engineering	3	0	3		
	Engineering Drawing	0	3	1		
Electrical Engineering Core (Breadth)	Communication Systems	3	3	4	6	23
	Electromagnetic Field Theory	3	0	3		
	Electrical Machines	3	3	4		
	Linear Control Systems	3	3	4		
	Breadth Core I	3	3	4		
	Breadth Core II	3	3	4		
Electrical Engineering Specialization Based Electives (Depth)	Depth Elective-I	3	3	4	5	19
	Depth Elective-II	3	3	4		
	Depth Elective-III	3	3	4		
	Depth Elective-IV	3	3	4		
	Depth Elective-V	3	0	3		
IDEE	IDEE-I	3	0	3	2	6 to 7
	IDEE-II	3	0/3	3 or 4		
Senior Design Project	Senior Design Project-I	0	9	3	2	6
	Senior Design Project-II	0	9	3		
	Industrial Training (Summer)	0	0	0	0	0
Total					27	92 to 93

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

Knowledge Area	Name of Course	Theory Contact Hours	Practical Contact Hours	Credit Hours (CH)	Number of Subjects	Total Credit Hours
Computing	Introduction to Computing	1	3	2	3	9
	Programming Fundamentals	2	3	3		
	Data Structures and Algorithms	3	3	4		
Computer (Systems) Engineering Foundation	Linear Circuit Analysis	3	3	4	9	29
	Electrical Network Analysis	3	3	4		
	Workshop Practice	0	3	1		
	Signals and Systems	3	3	4		
	Electronic Devices and Circuits	3	3	4		
	Digital Logic Design	3	3	4		
	Microprocessor Systems	3	3	4		
	Probability Methods in Engineering	3	0	3		
	Engineering Drawing	0	3	1		
Computer (Systems) Engineering Core (Breadth)	Computer Architecture and Organization	3	3	4	6	23 to 24
	Operating Systems	3	0/3	3/4		
	Data Communication	3	3	4		
	Database Management Systems	3	3	4		
	Software Engineering	3	3	4		
	Computer Communication Networks	3	3	4		
Electives (Depth)	Depth Elective – I	3	0/3	3/4	5	17 to 19
	Depth Elective – II	3	3	4		
	Depth Elective – III	3	0/3	3/4		
	Depth Elective – IV	3	3	4		
	Depth Elective – V	3	0	3		
IDEE	IDEE-I	3	0	3	2	6 to 7
	IDEE-II	3	0/3	3/4		
Senior Design Project	Senior Design Project-I	1	6	3	2	6
	Senior Design Project-II	1	6	3		
	Industrial Training (Summer)	0	0	0	0	0
Total					27	90 to 94

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
12. Computer Graphics
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:

1. George B. Thomas and Ross L. Finney, "Calculus and Analytic Geometry," Latest Edition, Addison-Wesley, ISBN: 0201531747.
2. George F. Simmons, "Calculus with Analytic Geometry," Latest Edition, McGraw-Hill, ISBN: 0070576424.

3. Gerald B. Folland, “Advanced Calculus,” Latest Edition, Prentice Hall, ISBN: 0130652652.
4. Monty J. Strauss, Gerald L. Bradley and Karl J. Smith, “Calculus”, Latest Edition, Prentice Hall, ISBN: 0130918717

Linear Algebra

Prerequisites: None

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

Course Outline:
Vectors, Vector Spaces, Matrices & Determinants, Cofactor and Inverse, Rank, Linear Independence, Solution of system of Linear systems, Positive Definite matrix, Linear Transformations, Operations on matrices, Inner products, orthgonality and least squares, Eigenvalue & Eigenvectors. Applications to Systems of Equations and to Geometry, Singular Value Decomposition.

Recommended Books:
1. Gilbert Strang, "Linear Algebra and Its Applications", 4th Edition, Thomson Brooks/ Cole, 2007.
2. James M Ortega, "Matrix Theory – A Second Course", Plenum, 1991.
3. Otto Bretscher, "Linear Algebra with Applications", 3rd Edition, Prentice Hall, 2005.
4. David Poole, "Linear Algebra – A Modern Introduction", Brooks/Cole, 2003.

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:
Ordinary Differential Equations of the First Order: Geometrical Considerations, Isoclines, Separable Equations, Equations Reducible to Separable Form, Exact Differential Equations, Integrating Factors, Linear First-Order Differential Equations, Variation of Parameters. Ordinary Linear Differential Equations; Homogeneous Linear Equations of the Second Order, Homogeneous Second-Order Equations with Constant Coefficients, General Solution, Real Roots, Complex Roots, Double Root of the Characteristic Equation, Differential Operators, Cauchy Equation, Homogeneous Linear Equations of Arbitrary Order, Homogeneous Linear Equations of Arbitrary Order with Constant Coefficients, Non-homogeneous Linear Equations. Modeling of Electrical Circuits. Systems of Differential Equations. Series Solutions of Differential Equations. Partial Differential Equations: Method of Separation of variables, wave, Heat & Laplace equations and their solutions by Fourier series method.

Recommended Books:

1. Michael Greenberg, "Advanced Engineering Mathematics", 1996, Prentice Hall publishers.
2. Erwin Kreyzig, "Advanced Engineering Mathematics", 7th edition, 1993, John Wiley & Sons Inc.
3. Zill, Prindle, Weber and Schmidt, "A First Course in Differential Equations", 1996, Brooks/Cole Publishing,
4. Dennis G. Zill, Michael R. Cullen. "Differential Equations with Boundary-Value Problems", 1996, Brooks/Cole Publishing,
5. C. H .Edwards, David E. Penney, "Elementary Differential Equations with Applications", 1993, Prentice Hall.

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:

Functions of Several Variables and Partial Differentiation. Multiple Integrals, Line and Surface Integrals. Green's and Stoke's Theorem. Fourier Series: periodic functions, Functions of any period P = 2L, Even & odd functions, Half Range expansions, Fourier Transform. Laplace Transform, Z-Transform.

Recommended Books:

1. "Multivariable Calculus: Early Transcendentals", (Stewart's Calculus Series)
2. Swokowski, Olinick and Pence, "Calculus and Analytical Geometry", Latest Edition, Thomson Learning EMEA, Ltd.
3. William Briggs, Lyle Cochran, Bernard Gillett, "Multivariable Calculus" 2010, Pearson Education.
4. Howard Anton, Albert Herr, "Multivariable Calculus", Latest Edition, John Wiley.

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:

Complex numbers and functions. Complex integration. Power series, Taylor series. Laurent series, residue integration. Laplace Transform. Use of Laplace transform in solving differential equations.

Recommended Book:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley. (latest Ed.).

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:
1. Steven C. Chapra and Raymond P. Canale, “Numerical Methods for Engineers,” Fifth Edition, 2006, McGraw-Hill, ISBN: 0073101567.
2. Curtis F. Gerald, “Applied Numerical Analysis,” Seventh Edition, 2003, Addison Wesley, ISBN: 0321133048

General Physics I: Mechanics and Wave Motion

Prerequisites: None

Course Outline:
Measurement. Motion along a straight line. Vectors. Motion in 2 and 3 dimensions. Force and motion. Kinetic energy and work. Potential energy and conservation of energy. Center of mass and rotation. Center of mass and linear momentum. Torque and angular momentum. Equilibrium and elasticity. Gravitation. Fluids. Oscillations. Waves. First and second law of thermodynamics.

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

General Physics II: Electricity and Magnetism

Prerequisites: General Physics I

Course Outline:

Electric charge. Electric field. Gauss's law. Electric potential. Capacitance. Current and resistance. Circuits. Magnetic fields. Magnetic fields due to currents. Induction and inductance. Electromagnetic oscillations and alternating current. Maxwell's equations.

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:

1. Kenneth H. Rosen, "Discrete Mathematics and its Applications", 6th Edition, 2006, Mcgraw-Hill Book Co.
2. Richard Johnsonbaugh, "Discrete Mathematics", 7th Edition, 2008, Prentice Hall Publishers.
3. Kolman, Busby & Ross, "Discrete Mathematical Structures", 4th Edition, 2000, Prentice-Hall Publishers.
4. Ralph P. Grimaldi, "Discrete and Combinatorial Mathematics: An Applied Introduction", Addison-Wesley Pub. Co., 1985.

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:

1. Brian Williams and Stacey Sawyer, “Using Information Technology”, McGraw-Hill, ISBN: 0072260718, (Latest Edition).
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:

1. Robert Lafore, "Object-Oriented Programming in C++", Prentice Hall, ISBN: 0672323087, (Latest Edition).
2. C. Thomas Wu, "An Introduction to Object-Oriented Programming with Java", Mc-Graw Hill.

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:

Data types, Arrays, Records, Set structure, Abstract Data Types**,** Sequential allocation, Linked allocation. Stacks (Sequential as well as Linked Implementation) Queues. (Sequential as well as Linked Implementation), Linked Lists, Recursive versus Iterative Algorithms, Applications, Towers of Hanoi, Linked Lists, Traversal, Insertion, Deletion, Doubly linked lists, Root Node, Terminal Node, Branch Node, Level of a Node, Degree of a node. , Binary Tree, Tree traversal, (In-order/Pre-order/Post-order traversal), Conversion of tree into binary tree/ Bin tree into a Heap,. Traversing and searching in a tree, Insertion: Deletion, Heap, Heap-sort, Graphs. Adjacency Matrix, Traversal, DFS, BFS, Path lengths, Shortest Path **Searching & Sorting Algorithms,** Insertion sort, Selections sort, Merge sort, Radix sort, Hashing.

Recommended Books:

1. Horowitz Sahni, "Fundamentals of Data Structures in C++", 1999.
2. Lipshutz, "Data Structures", Schaum Outline Series, 1999.
3. Weiss, "Data structures and algorithm analysis in C++".
4. A. M. Tanenbaum, "Data structures using C and C++", 2001.

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:

1. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition).

2. R E Thomas, A J Rosa and G J Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009
3. C Alexander and M Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill, 4th Edition, 2008
4. J D Irwin and R M Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
5. W Hayt, J Kemmerly and S Durbin, "Engineering Circuit Analysis", McGraw-Hill, 7th Edition, 2007.

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 wring 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:

1. Choudhury, "Elements of Workshop Technology", Vol. 1, MPP.
2. Chapman, "Workshop Technology", Part-I,II,III, CBS.

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:

1. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest edition).
2. R E Thomas, A. J. Rosa and G. J. Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009
3. C. Alexander and M. Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill, 4th Edition, 2008
4. J. D. Irwin and R. M. Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
5. W. Hayt, J. Kemmerly and S. Durbin, "Engineering Circuit Analysis", McGraw-Hill, 7th Edition, 2007.

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, L\laser 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".
2. A. S. Sedra and K. C. Smith, "Microelectronic Circuits", Oxford University Press, Latest Edition.

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:

1. Morris Mano and Charles R. Kime, “Logic and Computer Design Fundamentals”, Prentice Hall.
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:

1. Shawna Lockhart, “Tutorial Guide to AutoCAD”, Prentice Hall.
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:

1. A. Leon-Garcia, "Probability and Random Processes For Electrical Engineering", Pearson Education, 2nd Edition, 1994.
2. Sheldon Ross, "A First Course in Probability", Pearson Education, 6th Edition, 2002.

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:

1. Douglas V. Hall, "Microprocessor and Interfacing", Tata McGraw-Hill.
2. Charles Gilmore, "Microprocessors: Principles and Application", McGraw-Hill.
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:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and Systems", 2nd Edition, Prentice Hall, 1996
2. M. J. Roberts, "Fundamentals of Signals and Systems", McGraw-Hill, 2007
3. B. P. Lathi, "Linear Systems and Signals", 2nd Edition, Oxford, 2004

4. S. Haykin and B. Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002
5. C. L. Phillips, J. M. Parr and E. A. Riskin, "Signals, Systems, and Transforms", 4th Edition, Prentice Hall, 2007.

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;

Vector algebra, coordinate systems and transformations, Vector calculus, electrostatic fields in materials, electrostatic boundary value problems, resistance and capacitance calculation. Magneto-static fields, magneto-static fields and materials, inductance calculation. Faraday's Law, displacement current and Maxwell's equation.

Recommended Books:

1. William Hayt and John A. Buck, “Engineering Electromagnetics”, McGraw-Hill, ISBN: 0073104639, Latest Edition.
2. Sadiku, Matthew N, “Elements of Electromagnetics”, Oxford University Press, ISBN: 0195103688, Latest Edition.
3. J. D. Kraus, "Electromagnetics", John Wiley & Sons, Latest edition.
4. David K. Cheng, "Fundamentals of Engineering Electromagnetics", Addison Wesley.

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), Superhetrodyne 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
Pulse Modulation**:** Sampling and Quantization, Pulse Amplitude Modulation, Pulse Position and Pulse width Modulation, Quantization Noise, Signal to Quantization Noise Ratio, Pulse code Modulation, Delta Modulation, Frequency Shift Keying, Phase Shift Keying.

Recommended Books:.

1. Simon Haykin, "Communication Systems", John Wiley, Latest Edition.
2. B. P. Lathi, "Modern Digital and Analog Communication Systems", Oxford University Press.

Electrical Machines

Prerequisites: Linear Circuit Analysis

Objectives: Covers fundamental aspects of Electrical Machines.

Course Outline:

Introduction to Electrical Machinery Principles: Magnetic Field and Circuits, Magnetization curves Characteristics of hard and soft magnetic materials, losses.Transformers: Ideal Transformer, Single Phase transformer: Operation and Equivalent Circuit, auto-transformer. DC Machinery fundamentals: Basics, loop rotating between pole faces, Commutation, Windings, Armature reaction, Induced Voltage and torque equation. Power flow and losses, Types of DC motors, Permanent magnet DC motors. AC Machinery fundamentals: Rotating Magnetic Field, Magneto motive force and flux distribution, Induced Voltage and Torque, Windings, Power Flow and Losses, Introduction to Induction Machines. Special Purpose Motors: Introduction to Single phase Induction Motors, Switched Reluctance motors, Hysteresis motors, Stepper, brushless DC motors.

Recommended Books:

1. Stephen J. Chapman, "Electric Machinery Fundamentals", McGraw-Hill. (Latest Edition)
2. Fitzgerald, Kingsley and Umans, "Electric Machinery", McGraw-Hill. (Latest Edition)
3. Hindmarsh, "Electrical Machines", McGraw-Hill. (Latest Edition)

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:

Modeling of electrical, mechanical and biological control systems, Open and closed-loop systems, Block diagrams. Second order systems. Step and impulse response. Performance criteria. Steady state error. Sensitivity, s-plane system stability. Analysis and design with the root loci method. Frequency domain analysis, Bode plots, Nyquist criterion, gain and phase margins, Nichols charts. The State-space method, state equations, flow graphs, stability, compensation techniques. Simulation and Controller design using MATLAB.

Recommended Books:

1. Steffani, Savant, Shahian and Hostetter, "Design of Feedback Control Systems" 4th Edition, Saunders College Publications.
2. Katsushiko, Ogata, "Modern Control Engineering," McGraw-Hill, `5th Edition
3. R. C. Dorf and R. H. Bishop, "Modern Control Systems," 12th Edition
4. B. C. Kuo, "Automatic Control Systems" 7th Edition

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:

Introduction to distribution system. Urban, suburban and rural distribution systems. Primary, secondary and tertiary voltages. Radial and ring main systems, application of distribution transformers, estimation of load, load characteristics, substation switch gears and bus bar arrangements, calculation of voltage drop and regulation in distribution feeders. Grounding and earthing, distribution transformer neutral, earthing resistance, earthing practice in L.V. networks. Power Factor: Disadvantages and causes of low power factor, methods for improvement, application of shunt capacitors in distribution network. Batteries & Electrochemical Processes: Main types of batteries and their working, battery charging, electroplating, electrolysis and electro-metallurgical process. Cathodic protection of poles, gas pipes, oil pipes and water structures. Heating and Welding: Electric heating, resistance, induction and dielectric heating, electric furnaces, microwave heating, electric welding, resistance welding and its types. Fundamentals of Illumination Engineering: Laws, units and terms used, requirements for good lighting, illumination schemes for various situations (street lighting, commercial/industrial lighting, stadium/flood/stage/spot lighting etc.), types of lamps, their working and relative merit.

Recommended Books:

1. M. L. Anand, "A Text Book of Electrical Power", Latest Edition.
2. Turan Gonen, "Electrical Power Distribution System", Latest Edition.

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:

1. Klaas B. Klaassen and Steve Gee, “Electronic Measurement and Instrumentation,” 1996, Cambridge University Press, ISBN: 0521477298.T
2. H Kevin, JamesH, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control,” 2000, Newnes, ISBN: 0750646241.

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 (MOSFETSs) are covered.

Course Outline:

The transistor at low frequencies, biasing. The transistor at high frequencies. Multistage amplifiers. Feedback amplifiers analysis and design. Stability concepts and oscillators. Signal generators and wave shaping circuits. Power amplifiers.

Lab Outline:

Characteristics and Analysis of BJTs, FET and MOSFETs. Multistage Amplifiers, Feedback in amplifiers, Oscillators.

Recommended Books:

1. A. S. Sedra and K. C. Smith, "Microelectronic Circuits", Oxford University Press, Latest edition.

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:

1. Bruce S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann Publishers, Latest edition
2. A. S. Tanenbaum, "Computer Networks", Prentice Hall, Latest Edition.

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:

1. David A. Patterson, John L. Hennessy, "Computer Architecture: A Quantitative Approach", 3rd Edition, Morgan Kaufmann.

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:

1. Pressman, Roger S., "Software Engineering: A Practitioner's Approach", 6th Edition, Mc-Graw Hill.
2. Sommerville , "Software Engineering", 8th Edition, Pearson Education.

References:

1. Whitten, Bently and Dittma, "System Analysis and Design Methods", 5th Edition, Mc-Graw Hill.

2. F. Brooks, "The Mythical Man-Months by Anniversary Edition", Addison-Wesley.
3. Booch, Rumbaugh and Jacobson, "The Unified Modeling Language User Guide", 2nd Edition, Pearson.
4. Kernighan and Pike, "The Practice of Programming", Latest edition, Addison Wesley.
5. Telles and Hsieh, "The Science of Debugging", Latest edition, Coriolis Group Books
6. Doug Rosenberg and Kendall Scott, "Applying Use Case Driven Object Modeling with UML: An Annotated e-Commerce Example", Edition 2001, Pearson.

Operating Systems

Prerequisite: Data Structures and Algorithms

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

Course Outline:

History and Goals, Evolution of Operating systems, Process and CPU management, Problems of cooperative processes, Synchronization and scheduling algorithms, Deadlocks, Memory management and virtual memory, Relocation, External Fragmentation, Paging and Demand Paging, Secondary storage, Security and Protection, File systems, I/O systems, Multithreading, Kernel and User Modes, Protection, Introduction to distributed operating systems.

Recommended Books:

1. Operating Systems Concepts by Silberschatz A., Peterson, J. L., & Galvin P. C., 7th Edition, John Wiley & Sons.
2. Modern Operating Systems by Tanenmaum A. S., 3rd Edition, Prentice Hall.
3. Operating System by William Stallings, 6th Edition, Prentice Hall.

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:

1. C. J. Date, "Database Systems", Addison Wesley, 2004.
2. R. Cononolly and P. Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", Addison Wesley, 2009.

3. Elmasri and Navathe, "Fundamentals of Database Systems", Addison Wesley, 5th Edition.
4. Electrical Engineering Electives (Depth).

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:.

1. John G. Proakis and Masoud Salehi, "Digital Communications", 5th Edition, McGraw-Hill, 2007.
2. William C. Lindsey, Marvin K. Simon and Sami Hinedi, "Digital Communication Techniques – Signal Design and Detection", Prentice Hall, 1994.
3. S. Benedetto and E. Biglieri, "Principles of Digital Transmission: With Wireless Applications", Plenum, 1999.
4. E. A. Lee and D. G. Messerschmitt, "Digital Communications", Kluwer Academic, 2003.
5. J. G. Andrews, A. Ghosh and R. Muhamed, "Fundamentals of WiMax – Understanding Wireless Broadband Networking", Prentice Hall, 2007.

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:

1. John M. Senior, “Optical Fibre Communications: Principles and Practice”, Latest Edition, Prentice Hall, ISBN: 0136354262.
2. Gerd Keiser, “Optical Fibre Communications,” Latest Edition, McGraw-Hill, ISBN: 0072360763.
3. Harold Kolimbiris, “Fiber Optics Communications,” Latest Edition, Prentice Hall, ISBN: 0130158836.
4. Djafar Mynbaev and Lowell Scheiner, “Fibre-Optic Communications Technology,” Latest Edition, Prentice Hall, ISBN: 0139620699.

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:

Wireless channel models: path loss, shadowing, multipath fading, wideband channel models. Capacity of wireless channels, digital modulation, performance in wireless fading channels. Diversity (time, frequency, space), equalization. Multicarrier modulation (OFDM), spread spectrum (CDMA), cellular concept, frequency reuse. Multiuser systems, wireless networks.

Recommended Books:

1. Theodore S. Rappaport, "Wireless Communications", Latest Edition.
2. D. Tse and P. Viswanath, "Fundamentals of Wireless Communication", Latest Ed
3. William Stallings, "Wireless Communications & Networks by Pearson, Latest Ed
4. William Lee, "Wireless & Cellular Communications", McGraw-Hill, 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:

Basic Radar, The simple form of the Radar Equation, Radar block diagram, Radar frequencies, Application of the Radar, Origin of the Radar. Introduction to Radar equations, detection of signals in noise, receiver noise and signal to noise ratio, Probability density function, Probability of detection and false alarm, Integration of the Radar pulses, Radar cross section of targets, Transmitter power pulse repetition frequency. Introduction to Doppler and MTI radar, Delay line cancellors, Staggered pulse repetition frequencies, Limitation to MTI performance. Tracking with Radar, Monopulse tracking, Conical scan and sequential lobing. Linear beam power tubes, Solid state RF power sources, Magnetron, Cross field amplifiers, Other RF power sources, Other aspects of Radar transmitters. The Radar receiver, The receiver noise figure, Super Heterodyne receiver, Duplexers and receiver protectors, Radar displays. Introduction, Forward Scattering from a flat earth, Scattering from the round earth surface, Atmospheric Refraction, Standard propagation, Non-standard propagation, Diffraction, Attenuation by atmospheric gases, External environmental noise, Other propagation effects. Terminology used in navigational Systems, Direction finding, GPS, Laser Gyro, Decca, Loran, Beacon system, GIS, GNSS.

Recommended Books:

1. Merrill I. Skolnik, "Introduction to Radar Systems", Latest edition.
2. Gerry L Eaves & Edward K Reedy, "Principles of Modern Radar", Latest Edition.

Satellite Engineering

Prerequisites: Communication Systems

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

Course Outline:

Introduction to Satellite Communication, Satellite Link Design, Propagation Characteristics of Satellite Links, Satellite systems: Space-segment and ground segment, Channel Modeling, Access Control Schemes, System Performance Analysis, System Design, Space standards, Satellite Applications such as earth observation, weather, and communication.

Recommended Books:

1. Tom Logsden, "Mobile Communication Satellites: Theory and Applications", McGraw-Hill, (Latest edition).
2. Gerald M., Michel Bousquet, "Satellite Communication Systems: Systems, Techniques and Technologies", John Willey, (Latest Edition).
3. Leon W. Couch, “Digital & Analog Communication Systems”, Latest Edition, Prentice Hall, ISBN: 0131424920.
4. Theodore S. Rappaport, “Wireless Communications: Principles and Practice,” Latest Edition, Prentice Hall, ISBN: 0130422320.
5. Jochen Schiller, “Mobile Communications,” Latest Edition, Addison-Wesley, ISBN: 0321123816.
6. Timothy Pratt, Charles W. Bostian and Jeremy E. Allnutt, “Satellite Communications,” Latest Edition, 2003, John Wiley & Sons, ISBN: 0471429120.

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:

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

Recommended Books:

1. John D. Kraus, "Wave Propagation and Antennas", McGraw-Hill (Latest Edition).
2. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, (Latest Edition).

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:

Overview of Discrete-time systems. Application of z-transform for analysis of Linear Shift Invariant systems, Circular Convolution, Discrete Fourier Transform, Fast fourier Transform, Butterworth and Chebyshev approximation of analogue filters, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters, Design of FIR filter, Design of IIR Filter.

Recommended Books:

1. John G. Proakis and Dimitris K. Manolakis, "Digital Signal Processing – Principles, Algorithms and Applications," 4th Edition, Prentice Hall.
2. Sanjit K. Mitra, "Digital Signal Processing - A computer Based Approach", McGraw Hill, 2nd Edition.
3. A. V. Oppenheim and R. W. Schaffer, "Discrete-Time Signal Processing", 3rd Edition, Prentice Hall
4. A. Ambardar, "Digital Signal Processing – A Modern Introduction", Thomson.
5. R. J. Schilling and S. L. Harris, "Fundamentals of Digital Signal Processing Using MATLAB", Thomson.

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:

RF behavior of Passive Components and RF models, Chip components, Distributed Circuit elements, Strip Lines, Microstrip Lines, Coupled Striplines/Coupled microstriplines, Smith Chart, Impedance and Admittance Transformation, Parallel and series Connection, Impedance Matching Networks, Analysis of Single and Multiport Networks using Network Parameters, Microwave Filter Design, Microwave Amplifier design, Mixers and Detectors, Oscillators, Power dividers, Directional Couplers, Circulators, Microwave Systems.

Recommended Book:

1. David M. Pozar, "Microwave Engineering", Wiley India, 2009.

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 memory-less, 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:

1. Thomas M. Cover, "Elements of Information Theory", John Wiley.

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:

Introductory Mobile Concepts, Emerging Wireless Technologies & Applications, Issues & Challenges, The History & Evolution of cellular networks, PDAs & smart phones, Vision of Next generation, Location Awareness, HCI, Mobile Computing Research Projects: Oxygen, Smart Dust, AURA, Grid, Wireless technologies, frequency & spread spectrum, mobile Services, Wireless PAN, LAN & MAN, Cellular standard Groups, Mobile Terminal Platforms, Hardware platforms, Software Platforms & supporting tools, Mobile Networking challenges, Mobile IP, Next Generation Networks, Mobile Ad-hoc Networks, Quality of service in Mobile Computing, Mobile security & privacy, Cryptography, cellular network security, Ad-hoc network security, Bluetooth & WSN security, Mobile privacy, Location-aware computing, Navigation technologies, GNSS, GIS, Multimedia Streaming, M-commerce, Wireless village, M-banking, Mobile enterprise, Wireless gateway, Telematics applications, Wireless Wallets, Wireless Tele-medicines, Mobile Multimedia Messaging, Smart appliances, Smart Homes, Smart cars, Smart Dust, Grid & Utility computing, autonomous & edge computing, artificial life, HCI, implicit & explicit HCI, Mobile interfaces, Human-centered design.

Recommended Books:

1. P Zheng & L. M. Ni, "Smart Phone & Next Generation Mobile Computing", Morgan Kaufmann Publishers, Latest Edition.
2. S. Poslad, "Ubiquitous Computing: Smart Devices, Environments & Interactions", Wiley, Latest Edition

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:

Transmission Systems including PDH and SDH, Synchronization, routing techniques, Line Encoding Techniques (HDB3, 2B1Q), Types of Switching Review of switching technologies Circuit, Message and Packet Switching, Telecommunication Network (PSTN, PLMN), Exchanges Hierarchy, Basic Functions of a Typical Digital Switching Exchanges (examples taken from EWSD, AXE, SYSTEM12 etc), SPC, Software Structure of SPC Digital Switches, Software Life Cycle, Telecommunications Traffic and models including characterization of PABX and Public exchange traffic, GOS, BHCA, Network Traffic Load and Parameters, Blocking Probabilities, Modelling Switching Systems, Incoming Traffic and Service Time Characterization, Blocking Models and Loss Estimates, Delay Systems, Time and Space Switching, T-S-T and S-T-S Systems and its variations, Numbering Plans, Routing Tables, Charging Plans, Call detail recording(CDR), numbering plans, Classifications of Signalling Systems, Channel Associated Signalling (CAS) and Common Channel Signalling (CCS) ITU's Common Channel Signalling System # 7 (CCS7 Or SS7), – protocol Architecture mapping with OSI model, MSU, LSSU, and FISU, Global title translation, ISUP and TUP protocol maps, Case Study of FMM on Call Scenarios such as prefix Analysis and task element definition(PATED), isolation of condensed prefix(CPX), DNEU and Index, LSIF, TRA and Private Access Resource Management. ISDN Implementation in Commercial Exchange.

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:

1. Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols, and Standards", Latest Ed.
2. Puri, "Multimedia Systems, Standards and Networks", Marcel Dekker, Latest Ed.
3. Steve Heath, "Multimedia and Communication Technology", Focal Press, Latest Ed.
4. Bill Whyte, "Multimedia Telecommunication", Chapman and Hall, Latest Ed.

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

1. B. S. William, "Elements of Power System Analysis", McGraw Hill, Latest Ed.
2. B. M. Weedy, "Electrical Power Systems", Pergamon Press, Latest Ed..
3. Hadi Saadat, "Power System Analysis", Latest Ed.

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:

1. Arche W. Culp, "Principles of Energy Conversion", Latest Edition.
2. M.M. Wakel, "Power Plant Technology", McGraw-Hill, Latest Edition.

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:

1. S. Rao, "Commissioning, Operation and Maintenance of Electrical Equipment", Khanna Publisher, India, Latest Edition.
2. M. G. Say, "Alternating Current Machines", Latest Edition.

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

diagram of impedance relay, operation of impedance relay in different zones, reactance relay, differential protection of transformers, generator protection, bus bar protection, arc voltage, arc interruption, re-striking voltage and recovery voltage, resistance switching, current chopping circuit breaker, classification of circuit breakers, oil circuit breakers, airblast circuit breakers, air break circuit breakers, SFB6B circuit breakers, vacuum circuit breakers, operational mechanism and rating of circuit breakers.

Recommended Books:

1. S. Rao, "Switchgear and Protection", Khanna Publisher, Latest Edition.
2. Paithanker & Bhide, "Fundamentals of Power System Protection", Prentice Hall, Latest Edition.

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:

1. Woolen Barg, "Power Generation, Operation and Control", Latest Edition.
2. Trosten Cegral, "Power System Control Technology", Latest Edition.
3. P. Kundur, "Power System Stability and Control", Latest Edition.

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:

1. Stevenson, "Elements of Power System", Latest Edition.
2. Grainger and Stevenson, "Power System Analysis", Latest Edition.

Advanced Electrical Machines

Prerequisites: Electrical Machines

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

Course Outline:

Transformers: Equivalent Circuit, per unit system of measurement, voltage regulation and efficiency, three phase transformers, types of connections, testing, parallel operation. Synchronous Generators: Equivalent circuit and operations, Characteristics of Salient and Non-Salient poles, model parameters, Single and parallel operation, ratings. Synchronous Motors: Basic Principle, Equivalent Circuit, steady state operation: Torque speed characteristics, power factor correction, starting of synchronous motors, ratings, speed control. Induction Motors: Production of rotating field and torque, Construction, Synchronous speed, Slip and its effect on rotor frequency and voltage. Equivalent circuit. Power and torque. Losses, efficiency and power factor. Torque-speed characteristic. Starting and speed control. Induction generator.

Lab Outline: Based on above course contents

Recommended Books:

1. Stephen J. Chapman, "Electric Machinery Fundamentals", McGraw-Hill. (Latest Edition)
2. Hubert, "Electric Machines Theory, Operation, Applications, Adjustment and Control", Latest Ed.

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 conversation, buck converter, boost converter and buck-boost converters, isolated converters, forward converters, flyback converters.

Recommended Books:

1. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications", Prentice Hall, Latest Edition.
2. C. W. Lander, "Power Electronics", McGraw Hill, Latest Edition.
3. Philip T. Krein, "Elements of Power Electronics", Oxford University Press, Latest Edition.

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.

Course Outline:

Neuron, Brain, Central Nervous System, Neural information, Processing, The Classification Problem and Artificial Neuron, Hebbian Learning Adaline, Perceptron, Madaline Learning, Error estimates, Parameters, Convergence, structure of multi-layer perceptron, Activation Function, Learning, Back propagation, Choosing learning parameters, Generalization, overtraining Delta Delta Rule, Delta Bar Delta Rule, Speeding up convergence, BP Fuzzy Control RBF Network Kohonen's Map (SOFM) Essential processes, neighborhood functions, learning, SOFM Properties, Self-Organizing systems, Biological systems, principles of SO, SOFM models, Learning Vector Quantization, VQ, LVQ1, LVQ2, LVQ3, Recurrent Networks Hopfield network, Adaptive Resonance Theory

Recommended Books:

1. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2nd edition, Prentice Hall, 1999.
2. Robert J. Schalkoff, "Artificial Neural Networks", McGraw-Hill, 1997.
3. Christopher M. Bishop, "Neural Networks for Pattern Recognition", Clarendon Press, Oxford.

4. Laurene Fausett, "Fundamentals of Neural Networks, Architectures, Algorithms & Applications", Prentice Hall.
5. Mohamad H. Hassoun, "Fundamentals of Artificial Neural Networks", MIT Press, 1995.
6. George F Luger, "Artificial Intelligence", Addison Wesley.
7. N. Sinha, M. Gupta, "Soft Computing & Intelligent Systems".
8. Ripley, B. D. "Pattern Recognition and Neural Networks", Cambridge University Press (1996)
9. Bishop, C., "Neural Networks for Pattern Recognition", Oxford: University Press (1995).

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:

Concept of digital image, Types of images, Visual Perception, Light & Electromagnetic Perception, Image sensing &acquisition, : Spatial and luminance resolution parameters, Image Sampling and quantization, Imaging defects, Noise, Histogram Processing, Spatial Filtering, Convolution & Correlation, Smoothing & Sharpening, Fourier Transform, DFT, Frequency basaed filtering, Contrast enhancement & adjustment, Noise elimination: smoothing, Histogram manipulation (equalization, compression & Stretching, Image Restoration & Reconstruction, Edge detection, Image segmentation, Segmentation, Feature extraction, Image Coding & Compression, Applications

Lab Outline:

Image Sampling and quantization, Image Transform, Spatial Domain Filtering, Convolution & Correlation, Smoothing & Sharpening, Frequency Domain Filtering, Fourier Transform, DFT, Contrast enhancement & adjustment, Noise elimination: smoothing, Histogram equalization, compression & Stretching, Image Restoration & Reconstruction, Filtering, low pass (smoothing), high-pass (edge-enhancement). Edge detection techniques., Image segmentation, Feature extraction, Image Coding & Compression.

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:

1. Paulraj Ponniah. “Data Warehousing Fundamentals”
2. Thomas Connolly. “Database Systems”, 3rd Edition
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:

1. Project Management Handbook K. Pinto Editor, Jossey-Bass Publishers, 1998, ISBN 0-7879-4013-5.
2. Pressman R.S., "Software Engineering - A Practitioner's Approach”, Latest Edition, Mcgraw-Hill Inc.
3. Practical Software Metrics For Project Management and Process Improvement, by R. B. Grady, Prentice-Hall, Englewood Cliffs, NJ 07632 1992. ISBN 0-13-720384-5.
4. Effective Project Management, by Wisocki, Beck and Crane. John Wiley and Sons, Inc. 1995. ISBN 0-471-11521-5.
5. Project Management, Strategic Design and Implementation, 3rd edition, by David I. Cleland, McGraw-Hill, 1999, ISBN 0-07-012020-X.

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:

Introduction to software quality assurance, Fundamentals of software quality assurance practice, Software quality control processes, Software quality verification, Software quality measurement, Supporting tools for software quality control, The SEI Capability Maturity Model for Software, ISO 9000 for Software, Software Testing Techniques, Software Testing Strategies, Formal Methods, Software quality certification, Deploying a quality system.

Recommended Books:

1. Jerry ZeyuGao, H. S. Jacob Tsao, and Ye Wu, Testing and Quality Assurance for Component-Based Software, Artech House Publishers, 2003.
2. Frank P. Ginac, Customer Oriented Software Quality Assurance, Prentice Hall PTR; 1st Edition (December 1997).

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:

1. James Martin, James J., Odell, "Object Oriented Methods: A Foundation", 2nd Edition or Latest, Prentice Hall.
2. Robert Lafore, "Object-Oriented Programming in C++", Fourth Edition, 2002, Prentice Hall, ISBN: 0672323087, ISBN-13: 9780672323089

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

speed using pipelining, retiming, and parallel processing, Dedicated Fully Parallel Architecture, Time shared Architecture, Hardwired State Machine based Design, Micro Program State Machine based Design, FPGA-based design and logic synthesis,

Recommended Books:

1. Kevin Skahill, "VHDL for Programmable Logic", Addison Wesley, Latest Ed.
2. Peter J. Ashenden, "The Designer's Guide to VHDL", 2nd Edition, Morgan Kaufman
3. Samir Palnitkar, "Verilog HDL-A guide to Digital Design and Synthesis", 2nd Edition, Prentice Hall Publisher
4. Michael D. Ciletti, "Advanced Digital Design with Verilog HDL", Prentice Hall, Latest Ed.

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:

1. Adel S. Sedra and Kenneth C. Smith, "Microelectronic Circuits," Fifth Edition, 2003, Oxford University Press, ISBN: 0195142519T.T
2. Thomas L. Floyd and David M. Buchla, "Basic Operational Amplifiers and Linear Integrated Circuits," Second Edition, 1999, Prentice Hall, ISBN: 0130829870.

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:

1. Harold Kolimbiris, “Fibre Optics Communications,” First Edition, 2004, Prentice Hall, ISBN: 0130158836.
2. John M. Senior, “Optical Fibre Communications: Principles and Practice”, 3rd Edition, 2009, Prentice Hall.
3. Henry Zanger, Cynthia Zanger, "Fibre Optics: Communications and other Applications", Maxwell MacMillan International.

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:

1. Wayne Wolf, “FPGA-Based System Design,” with CD-ROM, 2004, Prentice Hall, ISBN: 0131424610.
2. Samir Palnitkar, “Verilog HDL,” Second Edition, 2003, Prentice Hall, ISBN: 0130449113.
3. Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL,” First Edition, 2003, Prentice Hall, ISBN: 0130891614.

4. Michael John Sebastian Smith, “Application-Specific Integrated Circuits,” First Edition, 1997, Addison Wesley, ISBN: 0201500221.

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:

1. Zainalabedin Navabi, “Verilog Computer-Based Training Course,” First Edition, 2002, McGraw-Hill, ISBN: 0071374736.

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:

1. Frank Vahid and Tony D. Givargis, “TEmbedded System Design: A Unified Hardware/Software Introduction,” 2001, John Wiley & Sons ISBN: 0471386782.

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:

Electric heating: Principles and applications; induction and dielectric heating; high-frequency welding. Spot welding control. Industrial drives: Speed control of DC, AC, and servo motors. Process control Systems, Measurement of non-electrical quantities: Temperature, displacement, pressure, time, frequency; digital industrial measuring systems. Ultrasonic generation and applications. Photo-electric devices. Industrial control using PLCs. Data acquisition for industrial processes. Distributed control system in process industries. Basic concepts of SCADA.

Lab Outline:

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

Recommended Books:

1. Frank D. Petruzella, “Programmable Logic Controllers,” Third Edition, 2005, McGraw-Hill, ISBN: 0078298520.
2. Frank D. Petruzella, “Industrial Electronics,” First Edition, 1995, McGraw-Hill, ISBN: 0028019962.

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:

1. Charles L. Phillips and H. Troy Nagle, “Digital Control System Analysis and Design,” Third Edition, 1995, Prentice Hall, ISBN: 013309832X.
2. H Benjamin C. Kuo H, “Digital Control Systems,” Second Edition, 1995, Oxford University Press, ISBN: 0195120647.
3. Mohammed S. Santina H, Allen R. Stubberud and Gene H. Hostetter, “Digital Control System Design,” Second Edition, 1995, Oxford University Press, ISBN: 0030760127.
4. Katsuhiko Ogata, “Discrete-Time Control Systems,” Second Edition, 1995, Prentice Hall, ISBN: 0130342815.

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:

1. Charles P. Poole Jr. and Frank J. Owens, “Introduction to Nanotechnology,” 2003, John Wiley & Sons, ISBN: 0471079359.
2. Massimiliano Di Ventra, Stephane Evoy and James R. Heflin Jr. (Editors), “Introduction to Nanoscale Science and Technology,” 2004, Kluwer Academic Publishers, ISBN: 1402077203.
3. Mark A. Reed and Takhee Lee (Editors), “Molecular Nanoelectronics,” 2003, American Scientific Publishers, ISBN: 1588830063.

COMPULSORY COURSES

ENGLISH

Functional English

Objectives: Enhance language skills and develop critical thinking.

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

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:

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A. J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506
3. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. Pages 20-27 and 35-41.
4. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

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:

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
2. Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 4354057 Pages 45-53.

3. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5
4. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
5. Reading and Study Skills by John Langan
6. Study Skills by Richard York.

Technical Writing and Presentation Skills

Objectives: Enhance language skills and develop critical thinking

Course Outline:

Presentation skills. Essay writing:Descriptive, narrative, discursive, argumentative. Academic writing: How to write a proposal for research paper/term paper. How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency). Technical Report writing. Progress report writing.

Recommended Books:

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3.
2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
3. Patterns of College Writing (4th Edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
4. The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editiors: 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

d) 1977-88
e) 1988-99
f) 1999 onward

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:

1. Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.
5. Wilcox, Wayne. The Emergence of Banglades, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. Enigma of Political Development. Kent England: WmDawson & Sons Ltd, 1980.
9. Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. The Political System of Pakistan. Boston: Houghton Mifflin, 1967.
12. Aziz, K. K. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987.
14. Haq, Noor ul. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research, 1993.

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 sub-ordinates 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:

Introduction to Sociology. Culture and Related Concepts. Interpersonal Relations. Social Stratification. Human Ecology. Population Dynamics. Community Development. Deviance and Crime. Sociology of Change and Development.

Recommended Books:

1. Allport, G. W. (1985). The Historical Background of Modern Social Psychology. New York, Random House.
2. Bernard, A. and T. Burgess (2004). Sociology, Cambridge University Press.
3. DuBrin, A. J. (2007). Human Relations: Interpersonal Job Oriented Skills. New York, Prentice Hall.
4. Gardezi, H. N., Ed. (1991). Understanding Pakistan: The Colonial Factor in Societal Development. Lahore, Maktaba Fikr-o-Danish.
5. Hafeez, S. (1991). Changing Pakistan Society. Karachi, Royal Book Company. Gardezi, H. N., Ed. (1991).
6. Jones, G. W. (2005). "Why are Population and Development Issues not Given Priority?" Asia-Pacific Population Journal 20(1).
7. Macionis, J. J. (1999). Sociology 7th Edition, National Book Foundation, Islamabad
8. Maser, C. (1997). Sustainable Community Development: Principles and Concepts. Florida St. Lucie Press.
9. Nelson, N. and S. Wright (1995). Power and Participatory Development: Theory and Practice. London, Intermediate Technology Publications.
10. Syed, S. H. (2003). The State of Migration and Multiculturalism in Pakistan: The Need for Policy and Strategy. Islamabad, UNESCO**:** 1-30.
11. Utton, A. E. (1976). Human Ecology, West View Press.
12. Webster, A. (1990). Introduction to Sociology of Development. London, Nacmillan Education Ltd.
13. Weiss, A. M. (2001). Power and civil society in Pakistan, Oxford University press.

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:

Introduction. Culture. Evolution and Growth of Culture. Language and Culture. Economic System. Marriage and Family. Political Organization. Religion and Magic. Culture Change.

Recommended Books:

1. Ahmad, Akbar S. 1990. Pakistani Society, Karachi, Royal Books Co.

2. Bernard, H. Russel. 1994. Research Methods in Anthropology, Qualitative and Quantitative Approaches. London: Sage Publications
3. Bodley, John H. 1994. Cultural Anthropology, California: Mayfield Publishing Co.
4. Brogger, Jan. 1993. Social Anthropology and the Lonely Crowd. New Delhi: Reliance Publishing
5. Ember, Carol R. & Ember Melvin. 2005. Anthropology, 11th ed. Englewood Cliffs: Prentice Hall, Ince. Harper and Row
6. Harris Marvin. 1987. Cultural Anthropology. New York: Harper and Row
7. Harris Marvin. 1985. Culture, People, nature; An Introduction to General Anthropology London: Harper and Row
8. Haviland, W. A. (2005). Anthropology: The Human Challenge. New York, Thomson Learning Inc.
9. Hertzler J. O. 1981. The Social Structure of Islam. Cambridge: Cambridge University Press.
10. Keesing, Roger m. 1998. Cultural Anthropology: A contemporary perspective. 3rd ed. New York: Harcourt Brace College Publishers.
11. Kottak, Conard Phillip. 2002. Anthropology: The Exploration of Human Diversity. 9th ed. Boston: McGraw Hill Higher Education.
12. Kennedy, Charles H. 1992. Pakistan London: Westview Press,.
13. Marron, Stanley. 1057. Pakistani Society and Culture. New Heaven
14. Wilson, Richard A. 1996. Human Rights, Culture and Context: Anthropological Perspective. London: Pluto Press.

Understanding Psychology and Human Behaviour

Course Outline:

What is psychology? Nature, scope and application with special reference to Pakistan. Different schools of psychology. Methods of psychology. Learning. Intelligence and artificial intelligence. Personality and its assessment. Understanding maladjustive behaviour. Positive emotional states and processes . Stress management and anger management .

Recommended Books:

1. Atkinson R. C., & Smith E. E. (2000), Introduction to Psychology (13th Ed.), Harcourt Brace College Publishers.
2. Fernald, L. D., & Fernald, P. S. (2005), Introduction to Psychology, USA: WMC Brown Publishers.
3. Hergenhahn, B. R. (2001). An Introduction to the History of Psychology, New York: Wadsworth.
4. Goodwin, C. J, (2000) Research in Psychology: Methods and Design, (3rd Ed.), New York: John Wiley & Sons.
5. Synder, C. R., & Lopez, S. J. (2007) Positive Psychology, USA, Sage Publications.
6. Allen, B. P. (1997), Personality Theories: Development, Growth and Diversity, (2nd Ed.), Boston: Allyn & Bacon.
7. Cohen, R. J., & Swerdlik, M. E. (2005) Psychological Testing & Assessment (6th Ed.), New York: McGraw-Hill.
8. Corcini, R., (2000). Current Psychotherapies. London: Thompson & Co Publishers.
9. Comer, R. J. (2004). Abnormal Psychology, USA: Freeman & Company.
10. Schwartz, B., Wassernman, E., & Robbins, S. (2002), Psychology of Learning and Behaviour, 5th Ed. Norton and Company.

Professional Psychology

Course Outline:

Introduction to professional psychology. Psychological testing. Educational psychology. Industrial/organizational psychology. Social psychology. Health psychology. Clinical psychology . Positive psychology. Legal, ethical, and professional issues.

Recommended Books:

1. Crow, L., & Crow, A. (2000) Educational Psychology, New Delhi: Eurosia Publishing House Ltd.
2. Spiegel, P. K., & Koocher, G. P. (1998), Ethics in Psychology, New York: Oxford University Press
3. Snyder, C. R., & Lopes, S.J. (2000), Handbook of Positive Psychology, New York: Oxford University Press.
4. Compton, W. C. (2005), Introduction to Positive Psychology, USA, Thomson Wadsworth.
5. Debra, L. N. & James Compbell Quick, (2000) Organizational Behaviour (3rd Ed), Cincinnat: South Western.
6. Fred Luthans, Alexander, D. S. & Edwin, A. Locke (2000) (Eds), Handbook of Principles of Organizational Behaviour, London: Blackwell.
7. Brannon, L. & Reist, J. (2000), Health Psychology: An Introduction to Behaviour and Health (4th Ed.), USA Wadsworth.
8. Donohue, W. & Ferguson, K. (Eds), (2003), Handbook of Professional Ethics for Psychologists; Issues, Questions and Controversies, London: Sage Publications.
9. Meyers, D. (2005), Social Psychology, 8th Ed. McGraw Hill Inc.
10. Cooper, J. & Hogg, M. (2003) Handbook of Social Psychology, Sage Publications
11. Halgin, R. P., Whitbourne, S. K., & Halgin, R. (2004), Abnormal Psychology: Clinical Perspectives on Psychological Disorders, New York: McGraw Hill.
12. Thorndike R. L., & Hage, E.P. (1995), Measurement and Evaluation in Psychology and Education (4th Ed), New York, MacMillan.

Organizational Behaviour

Course Outline:

Introduction to organizational behaviour. Structure and control in organization. Individual and work learning. Stress. Individual differences. Motivation and job satisfaction. Group and work. Group and inter-group behaviour. Leadership. Patterns of work. Conflict and consent in work. Organizational culture.

Recommended Books:

1. Finchan, R., & Rhodes, P. (2003), Principles of Organizational Behaviour, 3rd Oxford.
2. Noe, R., Hollenbeck, J. Gerhart, B., & Wright, P. (2006), Human Resource Management, 5th Ed., McGraw-Hill.
3. Newstrom John W. (2007), Organizational Behaviour, (12th Ed), McGraw-Hill.
4. Luthan Fred, (2005), Organizational Behaviour, McGraw Hill Inc.
5. Robins, Stephen, (2005), Organizational Behaviour, McGraw Hill Inc.

Introduction to Sociology

Course Outline:

The Nature of sociology: The study of social life. Exploring the global village. Sociology as a science. The sociological imagination. The development of sociology. Pioneers of sociology. Nature, scope and subject matter of sociology. Brief historical development of sociology. Society and community. Relationship with other social sciences. Social interaction processes. Social groups: Definition and functions. Types of social groups. Social institutions: Definition. Structure and function of social institutions. Inter-relationships among various social institutions. Culture and related concepts: Definition and aspects of culture. Elements of culture. Organization of culture. Other concepts, cultural relativism, sub cultures, ethnocentrism, culture lag. Socialization and personality: Role and status. Socialization. Culture and personality. Deviance and social control: Definition and types of deviance. Juvenile delinquency. Formal and information methods of social control. Social stratification: Approach to study social stratification. Caste class and race as basics of social stratification. Major perspectives in sociology: Functionalist perspective. Conflict perspective. Interactionstic perspective. Social control and deviance: Agencies of social control. Social stratification: Determinants of social stratification. Social mobility, types and definition. Dynamics of social mobility. Concept of social movement: Theories of social movement. Social and cultural change. Social and cultural change: Definition of social change: Dynamics of social change: Impact of globalization on society and culture: Resistance to change. Collective behaviour: Definition. Characteristics. Causes. Types . Social movements. Mob and crowd behaviour.

Recommended Books:

1. Neulreck, Kenneth, J. 2005, Sociology: Diversity, Conflict and Change, Boston
2. Barnard, Andy. 2004. Sociology, Cambridge University Press
3. Giddens, Anthony, 2004, Sociology 4th edition, Cambridge Polity Press
4. Albrow, Martin, 2003, Sociology, London Routledge.
5. Richard, T. Schaefer, 2003, Sociology 5th edition, McGraw-Hill College
6. Kendall, Diana, 2004. Sociology in our Times, 4th Ed, Wadsworth
7. Tyler Melissa, Wallace Claire & Abbott Pamela, 2005, An Introduction to Sociology, 3rd Ed. Routledge.

Critical Thinking

Course Outline:

The Power of critical thinking: Claims and reasons. Reasons and arguments. Arguments in the rough. The Environment of critical thinking: Perils of haunted mind. Self and the power of the group. Subjective and social relativism. Skepticism. Making sense of arguments: Arguments basics. Patterns. Diagramming arguments. Assessing long arguments. Reasons for belief and doubt: Conflict experts and evidence. Personal experience. Fooling ourselves. Claims in the news. Faulty reasoning: Irrelevant premises. Genetic fallacy, composition, division. Appeal to the person, equivocation, appeal to popularity. Appeal to tradition, appeal to ignorance, appeal to emotion. Red herring, straw man. Unacceptable premises: Begging the question, false dilemma. Slippery slope, hasty generalization. Faulty analogy. Deductive reasoning: Propositional logic: Connectives and truth values. Conjunction, disjunction, negation.

Conditional, checking for validity. Simple arguments, tricky arguments. Streamlined evaluation. Deductive reasoning: Categorical logic. Statements and classes. Translations and standard form. Terms, quantifiers. Diagramming categorical statements. Sizing up categorical syllogisms. Inductive reasons: Enumerative induction. Sample size, representativeness, opinion polls. Analogical induction. Casual arguments, testing for causes. Casual confusions. Inference to the best explanation: Explanations and inference. Theories and consistence. Theories and criteria. Testability, fruitfulness, scope, simplicity. Conservatism. Judging scientific theories: Science and not science. The scientific method, testing scientific theories. Judging scientific theories. Copernicus versus Ptolemy, evolution versus creationism. Science and weird theories. Making weird mistakes: Leaping to the weirdest theory, mixing what seems with what is. Misunderstanding the possibilities. Judging weird theories. Crop circles, talking with the dead.

Recommended Books:

1. Vaughn Lewis, 2005, The Power of Critical Thinking, Oxford University Press.
2. Paulsen David W., Cederblom Jerry: 2000, Critical Reasoning, Wadsworth
3. Restall Greg. 2005, Logic: An Introduction, Routledge.

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).

Philosophy of Religion: Proving the existence of God. Anselm, Aquinas, Paley, Dawkins (Selection). Justifying religious beliefs. Pascal: Pensees (Selection). James: The will to believe (Selection). Freud: The future of an illusion (Selection). Confronting the problems of evil. Mackie: Evil and omnipotence (Complete). Hick: Philosophy of religion (Selection).

Metaphysics: Idealism and materialism. Berkeley Three dialogues between Hylas and Pholonous (Selection). Armstrong Naturalism, materialism and first philosophy (Selection). The mid-body problem. Descartes: Meditations on first philosophy (Selection). O'Hear: Introduction to the philosophy of science (Selection). Dennett: The origins of selves (Complete). Pali: Canon (Selection). Penelhum: Religion and rationality (Selection).

Freedom to Choose: Libertarianism. James The dilemma of determinism (Selection). Taylor Metaphysics (Selection). Determinism. Hospers Meaning and free will (Selection). Skinner Walden Two (Selection). Compatibilism. Stace Religion and the modern mind (Selection). Radhakrishnan Indian philosophy (Selection).

Ethics: Fulfilling Human Nature. Aristotle Nicomachean Ethics (selection). Loving God. Augustine The Morals of the Catholic Church and the City of God (Selection). Following Natural Law. Aquinas Summa Theologiae (Selection). Doing One's Duty. Kant Fundamental Principles of the Metaphysics of Morals (Selection). Maximizing Utility. Mill Utilitarianism (Selection). Turning Values of Upside Down. Nietzsche Human, All too Human and Beyond Good and Evil

(Selection). Creating Ourselves. Sartre Existentialism is a Humanism (Selection). Hearing the Feminine Voice. Gilligan In a Different Voice (Selection). Baier What do Women Want in a Moral Theory (Selection).
Political and Social Philosophy: The State as Natural. Plato the Republic (Selection). Aristotle Politics (Selection). The State as a Social Contract. Hobbes Philosophical Rudiments Concerning Government and Society (Selection). Locke the Second Treatise of Government (Selection). Liberty of the Individual. Mill On Liberty (Selection). Alienation in Capitalism. Marx Economic and Philosophic Manuscripts of 1844 (Selection). Justice and Social Trust. Rawls A Theory of Justice (Selection). Nozick Anarchy, State, and Utopia (Selection). Held Rights and Goods (Selection). Women in Society. Wollstonecraft A Vindication of the Rights of Women (Selection). De Behaviour The Second Sex (Selection). The Value of Philosophy . Russel The Problems of Philosophy (Selection). Midgley Philosophical Plumbing (Selection).

Recommended Books:

1. Abel Donald C., Stumpf Samuel Enoch, 2002. Elements of Philosophy: An Introduction, 4th Ed. McGraw-Hill.
2. Scruton Roger, 2001. A short History of Modern Philosophy, 2nd Ed. Routledge.

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 Peter F. Drucker
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:

Introduction, overview and scope of discipline. The evolution and emergence of management thought. Management functions. Planning concepts, objectives, strategies and policies. Decision making. Organizing; departmentalization, line/staff authority, commitments and group decision making. Staffing: principles of selection, performance, career planning. Leading: Motivation, leadership, communication. Controlling: the system and process and techniques of controlling. Management and Society: future perspective.

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:

- Basic Concepts of Hadith. History of Hadith. Kinds of Hadith. Uloom –ul-Hadith. Sunnah & Hadith. Legal position of Sunnah. Study of selected texts of hadith.

Introduction to Islamic law & Jurisprudence:

- Basic Concepts of Islamic Law & Jurisprudence. History & Importance of Islamic Law & Jurisprudence. Sources of Islamic Law & Jurisprudence. Nature of Differences in Islamic Law. Islam and Sectarianism.

Islamic Culture & Civilization:

- Basic Concepts of Islamic Culture & Civilization. Historical Development of Islamic Culture & Civilization. Characteristics of Islamic Culture & Civilization. Islamic Culture & Civilization and Contemporary Issues.

Islam and Science:

- Basic Concepts of Islam and Science. Contributions of Muslims in the Development of Science. Quran & Science.

Islamic Economic System

- Basic Concepts of Islamic Economic System. Means of Distribution of wealth in Islamic Economics. Islamic Concept of Riba. Islamic Ways of Trade & Commerce.

Political System of Islam

- Basic Concepts of Islamic Political System. Islamic Concept of Sovereignty. Basic Institutions of Govt. in Islam.

Islamic History

- Period of Khilafat-e-Raashida. Period of Ummayyads. Period of Abbasids.

Social system of Islam

- Basic Concepts of Social System of Islam. Elements of Family. Ethical Values 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”
4. Mulana Muhammad Yousaf Islahi, Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan.
5. Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)
6. Mir Waliullah, “Muslim Jurisprudence and the Quranic Law of Crimes”, Islamic Book Service (1982)
7. H.S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep Publications New Delhi (1989)
8. Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001).

PROPOSED LIST OF SUBJECTS FOR M.Sc./MS/ME IN ELECTRICAL ENGINEERING

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
14. Renewable Energy Systems
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
24. Advanced Electrical Machine Design
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 Compatibility
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.