CURRICULUM

OF

AVIONICS ENGINEERING
FOR

BE/BS
ME/MS

(Revised 2012)

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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Contents

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).

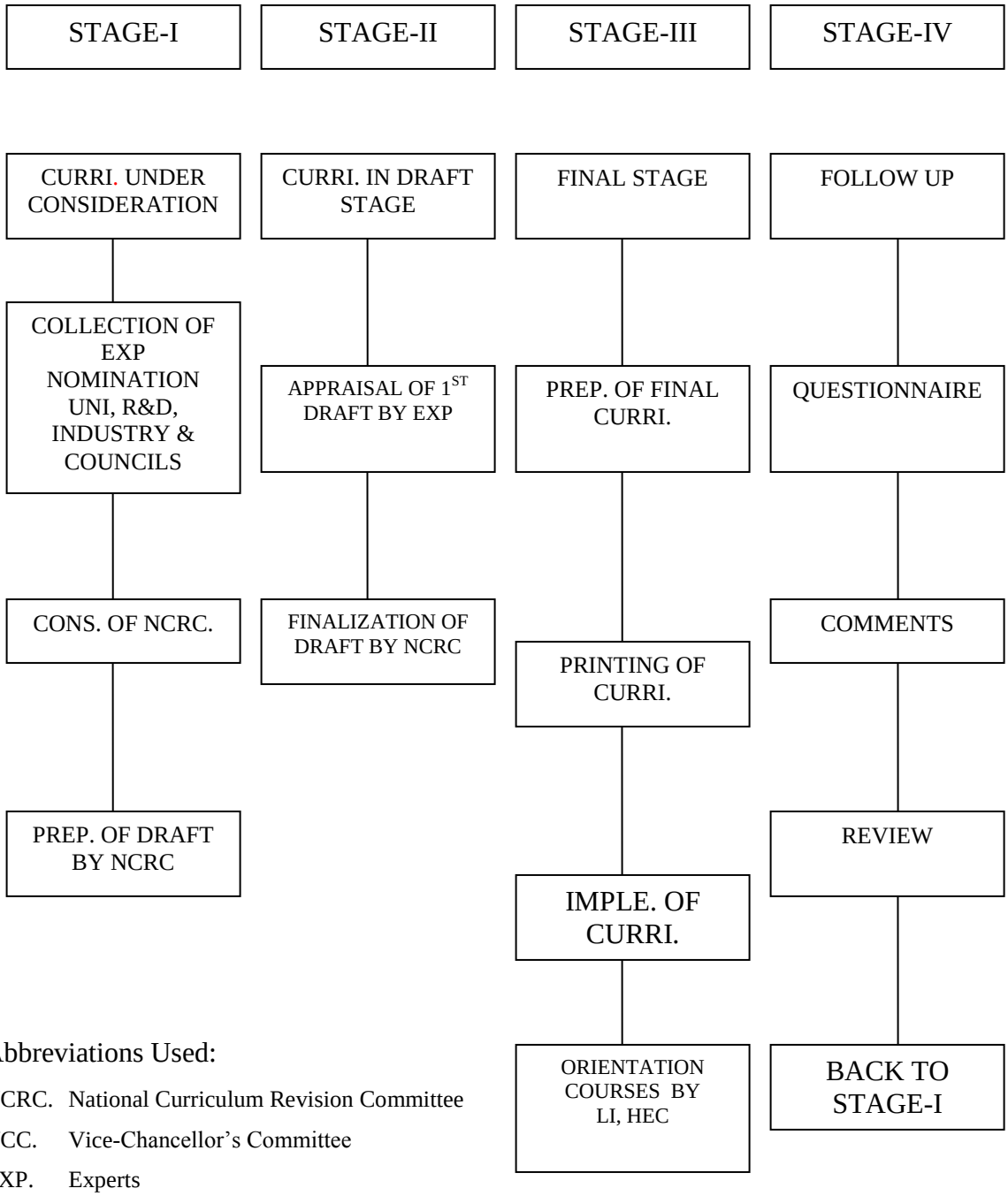
A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programmes in the country to bring the national curriculum at par with international standards, and to fulfil the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The BS degree shall be of 4 years duration, and will require the completion of 130-136 credit hours.

In line with above, NCRC comprising senior university faculty and experts from various stakeholders and the respective accreditation councils has finalized the curriculum for Avionics 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

A three-day meeting of the National Curriculum Revision Committee for Avionics Engineering (NCRC-Avionics Engineering) was held from 16-18 January, 2012 to finalize the revised curriculum for BE/BS and ME/MS Degree Programmes; drafted during an earlier meeting of the committee, held from September 15-17, 2011 at HEC Regional Centre, Lahore.

Participants of the Meeting

1.	Group Captain Dr. Jahangir Khan Kayani, Prof. & Head Avionics Engineering Dept. College of Aeronautical Engineering, PAF Academy, Risalpur National University of Sciences & Technology, (NUST)	Convener
2.	Air Commodore Dr. Khalid M Tahir, SI (M) Director General Institute of Avionics & Aeronautics (IAA) Air University, Islamabad	Member
3.	Brigadier Dr. Atiq-ur-Rehman, (PEC Nominee) Prof. & Head of Department, Faculty/Aeronautics and Astronautics, Institute of Space Technology (IST), SGS-SUPARCO, Rawat, Islamabad.	Member
4.	Air Commodore Dr. Abdul Munem Khan, Prof. & Dean, College of Aeronautical Engineering, PAF Academy, Risalpur	Member
5.	Major Dr. Muhammad Amin, Head EMI/EMC Lab SRDC-L, SUPARCO Samsani Road, Lahore	Member
6	Wg. Cdr. Dr. Muhammad Ajmal, Associate Professor, Department of Avionics Engineering, College of Aeronautical Engineering, PAF Academy, Risalpur	Member

General

At the start of the meeting, Mr. Muhammad Javed Khan, Advisor (Academics) HEC, welcomed the participants. He expressed his satisfaction over the participation of academia & industry representing both the public & private sector universities and institutions.

The participants agreed on Prof. Dr. Jahangir Khan Kayani as the Convener of the NCRC-Avionics Engineering. Dr. Jahangir Khan Kayani welcomed the participants and expressed his profound gratitude to the HEC for providing an opportunity to experts of public and private sector universities/organizations to contribute their knowledge and expertise to this important national cause. He also acknowledged the following universities/organizations for sending their representatives to participate in this important national cause:

- PAF College of Aeronautical Engineering, PAF Academy Risalpur, NUST
- Institute of Avionics & Aeronautics (IAA), Air University, Islamabad
- University of Karachi, Karachi
- Federal Urdu University of Arts, Sciences and Technology, Karachi
- Satellite Research and Development Centre (SRDC-L), Lahore SUPARCO, Karachi

Mr. Muhammad Javed Khan thanked all the participants for their valuable contribution to this national cause. He said that their efforts will go a long way in developing workable, useful and comprehensive degree programmes in Avionics Engineering.

The meeting authorized the Convener to submit the final draft of the Avionics Engineering curriculum to the Higher Education Commission. The meeting concluded with vote of thanks to the HEC Management and the participants.

Background

In February, 2004, a National Curriculum Revision Committee for Aerospace Engineering and Avionics Engineering (NCRC-Aerospace and Avionics) was formed. After two meetings in February and May, 2004, curricula for both the disciplines (Aerospace and Avionics) were developed. The curricula finalized by NCRC were adopted by institutions offering Bachelors and Masters Degrees in Aerospace and Avionics Engineering.

After Higher Education Commission developed a unified curricula for all engineering disciplines in Pakistan, need was felt to review / revise the curriculum developed by NCRC earlier in 2004. Consequently, a meeting of the National Curriculum Revision Committee was held on 01-03 Nov, 2007 to draft curriculum for Avionics Engineering degree programme. The objective was to review/revise the curriculum for Avionics Engineering in light of the unified framework/template for Engineering developed by the Convener of NCRCs in engineering disciplines.

From 24-26 March, 2008, a three-day meeting of the National Curriculum Revision Committee for Avionics Engineering (NCRC-Avionics) was held at HEC Regional Centre, Karachi.

After the curriculum review effort of 2007/2008, the current curriculum review is the next in the series. The objective now is to revise the curriculum in light of the latest advancements and technological trends.

Rationale for Avionics Engineering Education

"The Avionics Engineering education in Pakistan will focus on imparting to students the knowledge and training which should enable them to harmonize theory with practice, concept with application, and problem with solution. It will prepare them to amicably apply engineering principles, processes and practices to evaluate, analyze, design and develop avionics systems, and their maintenance. The programme will also, in addition to students' professional growth, attend to development of their personal skills. It will help students to enhance their ability in oral and written communication and interpersonal skills, and their adaptability to group-work environments. These programmes will inculcate among students a strong sense of civic, professional and ethical responsibility. These programmes will strive to develop in the professionals a capability for innovation and a passion for lifelong learning".

The curriculum thus developed will reflect the spirit as contained in the Rationale Statement and when implemented, will satisfy the professional demands of industry and academia. The graduates thus produced will be adequately equipped to exploit the opportunities and face the challenges offered by the modern world.

Goals for Avionics Engineering Education

"To transform Avionics engineering students into competent, successful and leading professionals for tomorrow and to prepare the students for lifelong learning in the fields relevant to their careers by providing sound academic foundation, practical prowess, opportunity for analytical thinking & design, experience in presentation, interpersonal communication & teamwork and awareness of ethical responsibility bonded with safety, service and professional conduct."

Knowledge Areas for Avionics Curriculum Development

The Chairman suggested to approach curriculum development systematically by identifying the major knowledge areas of Avionics Engineering education right at the outset. The following major areas are considered appropriate to design the curricula of Avionics Engineering:

1. Non-Engineering

(a) Humanities (English, Culture, Social Sciences)
(b) Management Sciences
(c) Natural Sciences (Mathematics, Physics, Chemistry)

2. **Engineering**

(a) Computing (Fundamentals, Programming, Design)
(b) Engineering Foundation
(c) Major Based Core Depth and Breadth (Circuits & Power Electronics; Digital & Embedded Systems; Electromagnetic, Microwave & Antenna; Communications; Modern Controls; Radars & Avionics Systems)
(d) Inter-disciplinary electives

The Committee also discussed suggestions received from local/foreign experts for the improvement of draft curriculum and incorporated suitable changes accordingly. The meeting recognized that good curriculum should focus on building a solid foundation in the early stages of learning and gradually introducing and strengthening the core professional competencies and desired skill-sets. The main technical content should be covered during the second, third and fourth years. Laboratory component should inculcate among students an industrious approach and practice towards problem solving. Good engineering practices must be nurtured all along the education programme. As the practices of Avionics Engineering are often in the context of multi-application domains, therefore, the graduates should be provided an opportunity of reasonably broad exposure to learn and demonstrate the application of engineering practices. A final year design project should provide the opportunity to bring together all the knowledge gained in a wide variety of courses to solve realistic problems.

Duration of Programme

The BE Avionics Engineering Degree programme would be minimum 4-year programmes spread over 8 semesters and MS Avionics Engineering programmes would be typically a 2-year programmes spread over 4-semesters.

Eligibility and Admission Criteria

The eligibility criteria for BE/BS Avionics Engineering were discussed. It was proposed that candidates must have completed FSc or A-level with physics, mathematics and chemistry or equivalent qualifications with at least 60% marks (requirement of PEC); however, universities may define their own admission criteria.

The eligibility criterion for admission to ME/MS Avionics Engineering was unanimously agreed to be BE/BS Engineering in the relevant field.

Admission criterion is to be decided by the institutes in the light of guidelines provided by the HEC.

BE/BS Programme Structure

All participants agreed that the proposed programme in Avionics Engineering meets the needs of learning outcomes in terms of knowledge outcomes and ability outcomes with relevant skills. The development of curricula is expected to enhance the theoretical and practical understanding of the field of Avionics

Engineering.

Minimum credit hours earned by a student shall be 130 for the award of BE/BS degrees in Avionics Engineering. Overall distribution must conform to the criteria laid down by HEC and PEC.

It was unanimously agreed that in addition to the curriculum for BE/BS in Avionics Engineering developed in conformity with the criteria laid down above, qualified and dedicated faculty along with standard laboratory facilities to support theoretical classroom instruction was the hallmark of quality education. HEC and PEC being two national bodies dealing with engineering education in the country must ensure availability of qualified and dedicated faculty along with standard laboratory facilities at universities/institutes offering BE/BS Avionics Engineering programmes.

Curriculum for BE/BS (Avionics)

Objectives of BE (Avionics) Programme

National Curriculum Revision Committee (NCRC) for Avionics Engineering after deliberation agreed to set the following goals for Avionics Engineering Education in Pakistan:

Breadth

To provide students with the broad education including knowledge of important current issues in engineering with emphasis on Avionics Engineering, necessary for productive careers in the public or private sectors, or for pursuing higher education.

Depth

To provide students with understanding of the fundamental knowledge for the practice of, or for advanced study in Avionics engineering, including its scientific principles, rigorous analysis, and creative design.

Professionalism

To develop skills for clear communication and responsible teamwork, and to inculcate professional attitudes and ethics, so that students are prepared for the complex modern work environment and for lifelong learning.

Learning Environment

To provide an environment that enables students to pursue their goals in an innovative programme that is rigorous and challenging, open and supportive.

Learning Outcomes of BE/BS (Avionics)

To prepare the students to achieve the programme educational objectives, following Programme Outcomes (PO), that is, statements that describe what students are expected to know and are able to do by the time of graduation, have been

definitized:-

(a) Ability to apply knowledge of mathematics, science, and engineering.
(b) Ability to design and conduct experiments as well as analyze and interpret data.
(c) Ability to design a system to meet desired needs.
(d) Ability to function on multidisciplinary teams.
(e) Ability to identify, formulate and solve engineering problems.
(f) Understanding of professional and ethical responsibility.
(g) Ability to communicate effectively.
(h) Broad education necessary to understand impact of engineering solutions in a global/societal context.
(i) Recognition of the need for and ability to engage in lifelong learning.
(j) Knowledge of contemporary issues.
(k) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
(l) Knowledge of probability and statistics, including applications to Avionics Engineering.
(m) Knowledge of mathematics and of basic and engineering sciences necessary to carry out analysis and design appropriate to Avionics engineering.
(n) Knowledge of advanced mathematics.

FRAMEWORK/TEMPLATE FOR BE/BS
AVIONICS ENGINEERING

Duration:	4 years
Number of semesters:	8
Weeks per semester:	16 - 18 (16 for teaching and 2 for exams)
Total credit hours:	130-136
Credit hours per semester:	15-18
Engineering Courses:	65-70 %
Non-Engineering Courses:	30-35 %

Non-Engineering Domain[1]

Knowledge Area	Subject Area	Name of Course	CR	Total Courses	Total Credits	% Area	% overall
Humanities	English	English-I (Functional English)	3	3	8	19.8%	6.2%
		English-II (Communica-tion Skills)	3				
		English-III (Tech. Report Writing)	2				
	Culture	Pakistan Studies	2	2	4	9.9%	3.1%
		Islamic Studies/ Ethics	2				
	Social Sciences	Social Sciences-I (Character Building)	1	4	5	12.3%	3.8%
		Social Sciences-II (Leadership)	1				
		Social Sciences-III (International Relations)	1				
		Social Sciences-IV (Engineering Economy)	2				
Manage-ment sciences		Professional Ethics & Practice	2	2	4	9.9%	3.1%
		Engineering Management	2				
	Elective	Statistical Quality Control	2				

		Product Design and Development	2				
Natural Science	Mathema-tics	Maths-I (Applied Algebra and Calculus)	3	4	12	29.6%	9.2%
		Maths-II (Advance Calculus & Transforms)	3				
		Maths-III (Differential Equations)	3				
		Advance Engineering Mathematics	3				
	Physics	Engineering Physics[2]	4	1	4	9.9%	3.1%
	Chemistry	Engineering Chemistry[2]	3.5	1	3.5	8.6 %	2.7%
TOTAL				**17**	**40.5**	**100.0**	**31.2 %**

Engineering Domain

Computing	Fundamentals	Introduction to Computer Programing	2	4	8	8.9%	6.2%
	Programming	Numerical Methods	3				
		Computer Aided Drafting	1				
		Computer Aided Instrumentation	2				
Engineering Foundation	Engineering Foundation	Engineering Statics	3	10	29.5	32.8%	22.7%
		Engineering Circuit Analysis - DC Circuit	2.5				
		Engineering Dynamics	3				
		Engineering Circuit Analysis - AC Circuits	2.5				
		Electronic Devices & Basic Circuits	3.5				
		Digital Systems - Logic Design & Devices	3.5				
		Electromagnetic Field Theory[1]	2.5				
		Signal & Systems	3.5				
		Analysis & Design of Control Systems	2.5				
		Probability & Statistics	3				
Major Based Core (Breadth)	Major Based Core (Breadth)	Electronics - Analog & Digital Integrated Circuits	3.5	6	19	21.2%	14.6%
		Digital Systems - Microprocessors & Microcontrollers	4				
		Transmission Lines & Waveguides	2.5				
		Modern Control System	2.5				
		Analog & Digital Communications	4				
		Electro Mechanical Systems	2.5				

Major Based Core (Depth)	Major Based Core (Depth)	Antenna Engineering	2.5	7	17.5	19.6%	13.5%
		Microwave Engineering	2.5				
		Radar Systems	2.5				
		Data Communication & Networks	2.5				
		Avionics System Design	4				
		Op-Amp Circuit Design	2.5				
		Emerging Aviation Technologies	1				
Inter-disciplinary Engineering Breadth	Inter Disciplinary Engg. Breadth	Thermodynamics of Propulsion[2]	3	4	9.5	10.6%	7.3%
		Applied Aerodynamics	3.5				
		Introduction to Aerospace Engineering	1				
		Workshop Technology[2]	2				
	Electives	IDEE (Electives) [3]	-				
Senior Design Project		Senior Design Project - I	3	2	6	6.7	4.6%
		Senior Design Project - II	3				
TOTAL				**33**	**89.5**	**100.0**	**68.8%**
Industrial Training		Industrial Training	0				
Grand Total				**50**	**130**		**100.0**

1. *Total credit hours of Non-Engg domain may be adjusted so as these remain within 30-35% of total credit hours of program.*
2. *May be offered as sequel of more than one courses*
3. *Details of courses under Inter-disciplinary Engineering Breadth (Electives)*

SCHEME OF STUDIES
FOR BE/BS (AVIONICS ENGINEERING)

Semester 1				Semester 2			
Course Title	**T**	**L**	**CH**	**Course Title**	**T**	**L**	**CH**
Applied Algebra & Calculus	3	0	3	Advance Calculus and Transforms	3	0	3
Engineering Physics-I	2	1.5	2.5	Differential Equations	3	0	3
Engg. Chemistry-I	2	1.5	2.5	Engineering Physics-II	1	1.5	1.5
Functional English	2	3	3	Engineering Statics	3	0	3
Islamic Studies	2	0	2	Engg. Chemistry-II	1	0	1
Workshop Technology-I	0	3	1	Workshop Technology-II	0	3	1
Pakistan Studies	2	0	2	Engineering Circuit Analysis-DC Circuits	2	1.5	2.5
Character Building	1	0	1	Communication Skills	2	3	3
Total	**14**	**9**	**17**	**Total**	**15**	**9**	**18**

Semester 3				Semester 4			
Course Title	**T**	**L**	**CH**	**Course Title**	**T**	**L**	**CH**
Advance Engineering Mathematics	3	0	3	Thermodynamics of Propulsion	3	0	3
Probability and Statistics	3	0	3	Electromagnetic Field Theory	2	1.5	2.5
Engineering Dynamics	3	0	3	Electronics-Devices and Basic ccts	3	1.5	3.5
Computer Aided Drafting	0	3	1	Introduction to Comp Programming	1	3	2
Intro to Aerospace Engg.	0	3	1	Signals & Systems	3	1.5	3.5
Engineering Circuit Analysis-AC Circuits	2	1.5	2.5	Electromechanical Systems	2	1.5	2.5
Digital Systems-Logic Design & Devices	3	1.5	3.5	Leadership	1	0	1
Total	**14**	**9**	**17**	**Total**	**15**	**9**	**18**

Semester 5				Semester 6			
Course Title	**T**	**L**	**CH**	**Course Title**	**T**	**L**	**CH**
Numerical Methods	2	3	3	Applied Aerodynamics-II	2	0	2
Digital Systems-Microprocessor & microcontroller	3	3	4	Antenna Engineering	2	1.5	2.5
Electronics-Analog & Digital Integrated ccts	3	1.5	3.5	Microwave Engineering	2	1.5	2.5
Analysis & Design of Control Systems	2	1.5	2.5	Engineering Management	2	0	2
Transmission Lines & Waveguides	2	1.5	2.5	Operational Amplifier Circuit Design	2	1.5	2.5
Applied Aerodynamics-I	1	1.5	1.5	Modern Control Systems	2	1.5	2.5
				Analog & Digital Communications	3	3	4
Total	**13**	**12**	**17**	**Total**	**15**	**9**	**18**

Semester 7				Semester 8			
Course Title	**T**	**L**	**CH**	**Course Title**	**T**	**L**	**CH**
Radar Systems	2	1.5	2.5	Project-II	0	9	3
Tech Report Writing	1	3	2	Emerging Aviation Technologies	1	0	1
Computer Aided Instrumentation	1	3	2	Professional Ethics and Practices	1	3	2
Data Communications & Networks	2	1.5	2.5	Engineering Economy	2	0	2
Avionics System Design	2	6	4	International Relations	1	0	1
Project-I	0	9	3				
Total	**8**	**24**	**16**	**Total**	**5**	**12**	**9**

Total Credit hours	**99**	**93**	**130**

NOTE:
This is a typical scheme of studies and Institutions may adjust the placement of courses within semesters, while remaining within the framework for BE/BS Avionics Engineering. Also any optional course from the template may be offered in any semester as considered appropriate.

DETAILS OF COURSES
FOR BE/BS AVIONICS ENGINEERING
NON-ENGINEERING DOMAIN
Functional English

Objectives: To 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
Introduction

Note: *Extensive reading is required for vocabulary building*

Recommended Books:

1. Functional English

a) Grammar

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

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
2. A Writer's Reference by Diana Hacker 2nd Ed (1992), Publisher Bedford Books of St. Marlins Press

c) Reading/Comprehension

1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking

Communication Skills

Objectives:

To enable the students to meet their real life communication needs

Course Contents

Paragraph writing
Practice in writing a good, unified and coherent paragraph

Essay writing
Introduction

CV and job application

Translation skills
Urdu to English

Study skills
Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

Academic skills
Letter / memo writing and minutes of the meeting, use of library and internet recourses

Presentation skills
Personality development (emphasis on content, style and pronunciation)

Note**:** *Documentaries to be shown for discussion and review*

Recommended Books:

Communication Skills

a) Grammar

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.

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
3. Business and Professional Communication in the Global Workplace Skills, Ethics, and Technologies by Jr. H. L. Good-all, Sandra Good-all, and Jill Schiefelbein Publisher Wadsworth 2009

c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
2. Reading and Study Skills by John Langan
4. Study Skills by Richard Yorky.

Technical Report Writing

Objectives:

To enhance language skills and develop critical thinking

Course Contents

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

Note: *Extensive reading is required for vocabulary building*

Recommended Books:

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
2. College Writing Skills by John Langan. Mc-Graw-Hill Higher Education. 2004.

3. Patterns of College Writing (4th Edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.
4. A Guide to Technical Report Writing. (2010)
5. Technical Report Writing today by Pauley Riordan. (2006)

b) Reading

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).

Islamic Studies (Compulsory)

UNIT NO. 1: INTRODUCTION TO QURANIC STUDIES

1) Basic Concepts of Quran
2) History of Quran
3) Uloom-ul -Quran

UNIT No. 2: STUDY OF SELECTED TEXT OF HOLLY QURAN

1) Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verses No-1-11)
4) Verses of Surah al-Furqan Related to Social Ethics (Verses No.63-77)
5) Verses of Surah Al-Inam Related to Ihkam (Verses No-152-154)

UNIT No. 3: STUDY OF SELECTED TEXT OF HOLLY QURAN

1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No. 6, 21, 40, 56, 57, 58.)
2) Verses of Surah Al-Hashar (18,19, 20) Related to thinking, Day of Judgment
3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verses No-1,14)

UNIT NO. 4: SEERAT OF HOLY PROPHET (S.A.W) I

1) Life of Muhammad Bin Abdullah (Before Prophet Hood)
2) Life of Holy Prophet (S.A.W) in Makkah
3) Important Lessons Derived from the life of Holy Prophet in Makkah

UNIT NO. 5: SEERAT OF HOLY PROPHET (S.A.W) II

1) Life of Holy Prophet (S.A.W) in Madina
2) Important Events of Life Holy Prophet in Madina

3) Important Lessons Derived from the life of Holy Prophet in Madina

UNIT NO. 6: INTRODUCTION TO SUNNAH

1) Basic Concepts of Hadith
2) History of Hadith
3) Kinds of Hadith
4) Uloom-ul-Hadith
5) Sunnah & Hadith
6) Legal Position of Sunnah

UNIT NO. 7: SELECTED STUDY FROM TEXT OF HADITH

UNIT NO. 8: INTRODUCTION TO ISLAMIC LAW & JURISPRUDENCE

1) Basic Concepts of Islamic Law & Jurisprudence
2) History & Importance of Islamic Law & Jurisprudence
3) Sources of Islamic Law & Jurisprudence
4) Nature of Differences in Islamic Law
5) Islam and Sectarianism

UNIT NO. 9: ISLAMIC CULTURE & CIVILIZATION

1) Basic Concepts of Islamic Culture & Civilization
2) Historical Development of Islamic Culture & Civilization
3) Characteristics of Islamic Culture & Civilization
4) Islamic Culture & Civilization and Contemporary Issues

UNIT NO. 10: ISLAM & SCIENCE

1) Basic Concepts of Islam & Science
2) Contributions of Muslims in the Development of Science
3) Quranic & Science

UNIT NO. 11: ISLAMIC ECONOMIC SYSTEM

1) Basic Concepts of Islamic Economic System
2) Means of Distribution of wealth in Islamic Economics
3) Islamic Concept of Riba
4) Islamic Ways of Trade & Commerce

UNIT NO. 12: POLITICAL SYSTEM OF ISLAM

1) Basic Concepts of Islamic Political System
2) Islamic Concept of Sovereignty
3) Basic Institutions of Govt. in Islam

UNIT NO. 13: ISLAMIC HISTORY

1) Period of Khlaft-e-Rashida
2) Period of Ummayyads
3) Period of Abbasids

UNITNO. 14: SOCIAL SYSTEM OF ISLAM

1) Basic Concepts of Social System of Islam
2) Elements of Family
3) 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,"
5) Hussain Hamid Hassan, **"An Introduction to the Study of Islamic Law"** leaf Publication Islamabad, Pakistan.
6) Ahmad Hasan, **"Principles of Islamic Jurisprudence"** Islamic Research Institute, international Islamic University, Islamabad (1993)
7) Mir Waliullah, **"Muslim Jrisprudence and the Quranic Law of Crimes"** Islamic Book Service (1982)
8) H. S. Bhatia, **"Studies in Islamic Law, Religion and Society"** Deep & Deep Publications, New Delhi (1989)
9) Dr. Muhammad Zia-ul-Haq, **"Introduction to Al Sharia Al Islamia"** Allama Iqbal Open University, Islamabad (2001)

Pakistan Studies (Compulsory)

(As Compulsory Subject for Degree Students)

Introduction/Objectives

The course has been designed as a compulsory subject for the students studying for Bachelor's degree, general or professional. The course is of 2 credit hours with teaching work divided into three distinct dimensions: Historical Perspective (20%); Government and Politics (40%); and Contemporary Pakistan (40%).

The course framework is issue-oriented. It has many dimensions, the historical and ideological background of Pakistan the process of governance and national development as well as the issues arising in the modern, age and posing challenges to Pakistan. The course has been designed with a vision that Pakistan Studies should open a window to future.

Course Outline:

1. Historical Perspective

a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-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.

2. 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

3. 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.
15. Pakistan's Foreign Policy: A Reappraisal by Shahid Amin, 2nd Ed (2010)
16. Human Rights: Pakistan Studies Compulsory: HEC Islamabad. (2007).

Social Sciences

Title of the Course: Character Building

Credit Hours: 1-0

Prerequisites: Nil

Specific Objectives of course:
To comprehensively introduce various essential attributes for character building with emphasis on values, attitudes, moral code, ethics, and character.

Course Outline:
Character building is essential for the future leaders, managers and entrepreneurs. Course covers values [sources, types, universal & non-universal, and features]; desirable and healthy attitudes, moral code of Islam; Ethics [definition, characteristics, decision making process]; and Good character [introduction and components].

Lab Outline: Nil

Recommended Books:
- Engineering ethics by Charles E. Harris Jr, Michael S. Pritchard.
- Ethics-concepts and cases by Charles E. Harris Jr, Michael S. Pritchard
- A Guide to Ethics by Steven Luper
- Ethics for life by Judith A. Boss
- The Seven Habits of Highly Effective People by Stephen R. Covey
- How to Manage by Ray Wild
- The Concept of Happiness by Bertrand Russel
- Winning Attitudes by Air Commodore Aslam Bazmi

Title of the Course: Leadership

Credit Hours: 1-0

Prerequisites: Nil

Specific Objectives of Course:
To comprehensively introduce the subject of leadership with emphasis on various theories, indicators, functions, responsibilities, qualities and principles of effective leadership.

Course Outline:
Leadership training is essential for the future leaders, managers, and entrepreneurs. Leadership, being a task of great responsibility, demands courageous, selfless and devoted behaviour. Topics included are definition, theories, concept, and indicators of effective leadership; various individual, leader-task, and team maintenance functions; traits, responsibilities, qualities, principles and approaches of leadership.

Lab Outline: Nil

Recommended Books:

- The Seven Habits of Highly Effective People by Stephen R. Covey
- How to Manage by Ray Wild
- Rules and Tools for Leaders by Major General Perry M. Smith

Title of the Course: International Relations

Credit Hours: 1-0

Prerequisites: Nil

Specific Objectives of Course:

To introduce the complex and ever-changing geo-political environment through a study and analysis of the behaviour of nation states in the contemporary international states system.

Course Outline:

The new realities after the 9/11 emphasized new geopolitical dimensions of the international relations. The old concepts have been replaced by the new ones to cater for the complex and ever-changing global geo-political environment. Apart from the basic concepts of the subject, some current issues such as new world order, terrorism, Iraq crisis, Afghanistan problem and Indo-Pak dialogue have also been included in the syllabus which makes it more relevant & updated for the students.

Lab Outline: Nil

Recommended Books:

- International Affairs by Dr Safdar Mehmood. 22nd Ed (2004)
- International Politics: A Framework for Analysis by K. J. Holsti. 4th Ed (1983)
- International Relations by Palmer & Perkins. 3rd Ed (1969)

Title of the Course: Engineering Economy

Credit Hours: 2-0

Prerequisites: Elements of Applied Algebra & Calculus

Specific Objectives of Course:

To familiarize students with the nature and purpose of engineering economy studies and relationship between the engineering and management functions with an emphasis on their increasing interdependence in today's world.

Course Outline:

Selected cost terms and other cost concepts like break-even analysis; the average unit cost function and present economy studies; concept of money-time relationships specifically the development of proper techniques to consider the time value of money in manipulating the future revenues; and costs associated with various alternatives.

Lab Outline: Nil

Recommended Books:

Text Book:

- Engineering Economy by E. Paul DeGarmo, Sullivan, Canada. 9th Ed (1993)

Reference Book:

- Principles of Engineering Economic Analysis by John A, White.

Management Sciences

Title of the Course: Professional Ethics & Practices

Credit Hours: 1-1

Prerequisites: Nil

Specific Objectives of course:

To expose students to ethical issues that engineers often face in professional practice, to help students think more clearly and deeply about such issues, and to explore resources and strategies, options to handle such situations. To make students acquainted with the legal aspects particularly pertaining to operational health and safety and environmental issues.

Course Outline:

To prepare students for working on large projects with multidisciplinary teams where decisions made by other groups will affect choices made by their groups and to reinforce the reality that in most engineering projects engineers present their work to organizational, governmental and legal authorities for approval. During this entire discourse, this course emphasises that engineers must adhere to and demonstrate ethical, responsible and professional behaviour towards organization, profession and society through professional and ethical practices. Therefore, the course has designed around the topics that include ethical and moral obligations and rights and responsibilities of engineers in relation to society, employers, colleagues, and clients; cost-benefit-risk-analysis, safety, and informed consent; the ethics of whistle blowing; ethical conflicts of engineers as experts, managers and supervisors; ethical issues in engineering design, manufacturing, and operations; ethical issues arising from engineering work; ethical implications of the social and environmental contexts of contemporary engineering; and professional code of ethics.

The students will be given introduction and overview of the generic standards applicable to operational health and safety. OHSAS18001 and OHSAS18002 (or equivalent standards) might be referred as guideline.

Students will be also made aware of their social responsibility towards environmental protection. An overview/introduction to Environmental Management Standard (EMS) 14001 (or equivalent) may be included.

Lab Outline: Nil

Recommended Books:

- IEEE Code of Ethics
- Engineering Ethics, Concepts and Cases by Jr Charles E. Harris. 4TH Ed (2009)
- Ethics in Engineering by Mike E. Martin. 4th Ed (2005)
- Engineers and their Profession, 4th Ed by J. D. Kemper, NY Saunder, 1990
- Educating Ethical Engineers by W. Sweet, IEEE Spectrum, Vol. 36 No 6, pp 51-62, June, 1998.
- Controlling Technology: Ethics and Responsible Engineer, 2nd Ed, by S H Unger, New York, Wiley 1994.
- Ethical Issues in Engineering, by D. G. Johnson, Englewood Cliffs, NJ Prentice-Hall, 1991.
- Legal and Ethical Concepts in Engineering, by K W Blinn, Englewood Cliffs, NJ Prentice-Hall, 1989.
- Business Ethics by Joseph W. Weiss
- Developing Professionalism in the Electrical Engineering Classroom, by W. W. Cooley, P Klinkhachorn, R. L. McConnell, and N T Middleton, IEEE Transactions, Educations, Vol. 34, pp 149-154, May, 1991.
- OHSAS 18001(Specification) and OHSAS18002 (Guideline)
- EMS 14001 Standard

Title of the Course: **Engineering Management**

Credit Hours: 2-0

Prerequisites: Engineering Economy

Specific Objectives of course:

To present the basic principles of production and various functions of operations management and its application in different types of manufacturing systems. To acquaint the students with the various management systems for quality management and configuration management. To give the students an overview of multi-attribute decision making.

Course Outline:

Zeroing on Operations, Strategic Guidance for Operations, Product development & design, Facility Location, Layout of Facilities, Application of Technology for Competitive Advantage, Planning for Operations & Capacity, Materials Management, Managing Independent Demand Inventory, Scheduling & Controlling Manufacturing, Project Management.

Introduction to Enterprise Resource Planning (ERP)
Introductory overview of multi-attribute decision making tools e.g. TOPSIS, AHP. PROMETHEE, VIKOR

Introduction to contemporary quality management system standards like ISO9000 (or equivalents) and its Aerospace version i.e. AS9100

Introduction to concepts of Configuration Management and Document and Data Control. Compilation of Technical Data Pack (TDP), types of documents comprising TDP and concept of Engineering Change Control

Emerging Technologies such as JIT, Lean manufacturing, 5S, Six Sigma, Concurrent Engineering, Rapid Prototyping, and CNC machines, their programming and operation.

Lab Outline:

Introduction to CNC machines including engraving, milling, and lathe, programming functions for milling and lathe machines, and MS Project.

Recommended Books:

- Operation Management by Jay Heizer & Barry Render, 8th Ed (2007)
- Project Management Body of Knowledge (PMBOK) Ed 2004 by PMI
- Production & Operations Management: Concepts, Models and Behaviour by Everett E. Adam, JR. & Ronald J. Ebert
- Bible for MS Project 2003
- Software Manual, Milling for Windows, INTELYS
- Software Manual, Turning for Windows, INTELYS
- ISO 9001 Quality management systems-Requirements
- SAE AS9100 Quality Management Systems - Requirements for Aviation, Space and Defense Organizations
- ISO 10007 Quality management systems - Guidelines for configuration management
- MIL-HDBK-61A(SE) Military handbook-Configuration management guidance
- MIL-STD 31000 Technical data packages

Mathematics

Title of the Course: Applied Algebra and Calculus

Credit Hours: 3-0

Prerequisites: **Intermediate / HSC Level Mathematics**

Specific Objectives of Course:

To provide comprehensive foundation of applied algebra and calculus with emphasis on vectors, complex numbers, matrices, limits, differentiation, integration, and coordinate systems.

Course Outline:

Complex numbers and De Moivre's theorem, determinants, matrices, product, inversion, rank, system of equations and Cramer's rule, synthetic division, remainder and factor theorem, roots of polynomial equations, graphical method and transcendental equations. Limit, continuity and differentiation involving algebraic, trigonometric, hyperbolic, implicit and composite functions; application to rates and small corrections, simple Cartesian, parametric and polar curves; tangent, normal, maxima and minima, Taylor and Maclaurin series; curvature. Integration as inverse

of differentiation, by substitution, by parts and partial fraction; definite integrals (Wallis formula); integral as limit for a sum, area and arc length of plane figures, volumes and surfaces of solids of revolution.

Lab Outline: Nil

Recommended Books:

Text Books :

- Integrated Algebra and Trigonometry by Fisher and Zeibur.1st Ed (1965)
- Calculus and Analytic Geometry by Thomas.9th Ed (2007)
- Mathematical Methods by S. Ramachary and M.B. Rao et al. (2005)

Reference Books:

- College Algebra by Rees and Sparks.
- Practical Mathematics Vol. I & II by Toft and Meckay.
- Unified Calculus and Analytic Geometry by Rainville.
- Vector analysis by Schaum series
- Basic Technical mathematics with Calculus by Peter Kuhfitting
- Linear Algebra and its Applications by David C Lay.
- Mathematical Methods by S. Ramachary and M. B. Rao et al. 2005.

Title of the Course: Advanced Calculus & Transform

Credit Hours: 3-0

Prerequisites: **Applied Algebra and Calculus**

Specific Objectives of Course:

To provide comprehensive knowledge of basic principles, methods, and clear perception of advanced calculus used extensively in nearly all the engineering fields especially in Mechanics, Structures, Communications and Electronics.

Course Outline:

Analytic Solid Geometry [Equation of a line in symmetrical form, angle between two lines; Angle between two planes. Distance from a point to a plane; Distance from a point to a line. Coordinates of a point dividing a given line in a given ratio; General form reduced to normal, to find the equation of a plane passing through three points or by any set of three independent conditions; Normal form of an equation of a plane, general form of an equation of a plane; Parallel, intersecting and skew lines. The distance between two parallel planes; Shortest distance between two lines (Skew or parallel); Definition of surfaces; Spherical & Cylindrical Co-ordinates. Direction ratio's], **Partial Differentiation** [Function of several independent variables; Partial derivatives. Geometrical interpretation of partial derivatives; Equation of a tangent plane and normal line; Total Differentiation. The derivative of composite function; Partial derivative of higher order and problems; Taylors theorem for function of two variables; Maxima and minima of functions of two variables], **Infinite series** [Introduction to infinite series; Convergence by comparison test and P-series; Absolute convergence and conditional convergence; Integral test and root tests; Ratio test and power series; domain of convergence], **Multiple Integration** [Definition of double integration. Evaluate the double integral

with the order of integration reversed; Using double integration find plane area in Cartesian, polar coordinates. (a) Centre of gravity of a plane figure. (b) Moment of inertia of a plane lamina; Volume and surface areas in Cartesian, cylindrical and spherical coordinate systems; Centre of gravity of volume using Cartesian, cylindrical and spherical coordinates; Moment of inertia of volume, surface area; Ratio test and power series; domain of convergence], **Fourier Series** [Introduction to Fourier Series; To evaluate Fourier Constants and write down Fourier expansions; Even and odd functions and their Fourier expansions; Half range Fourier Series; Complex Fourier Series; Fourier Integrals].

Lab Outline: Nil

Recommended Books:

Text Books :

- Calculus and Analytic Geometry by Thomas 9th (2007)
- Advanced Engineering Mathematics by Kreyszig 9th (2006)

Reference Books :

- Analytic Geometry and Calculus with Vectors by Agnew
- Practical Mathematics Vol-I & II by Toft & McKay
- Advanced Calculus for Application by Hildebrand
- Vector calculus by Bedford F. W. & Dwivedi
- Advanced Engineering Mathematics by Zill & Cullen.

Title of the Course: Differential Equations

Credit Hours: 3-0

Prerequisites: **Applied Algebra & Calculus, and Advanced Calculus & Transforms**

Specific Objectives of Course:

To provide detailed knowledge of basic principles, methods, and clear perception of ordinary differential equations and partial differential equations used in engineering fields especially in Mechanics, Dynamics, Structures, Communications and Electronics.

Course Outline:

First Order Ordinary Differential Equation [Introduction to differential equation, Solution by separation of variables, Differential equations with homogeneous coefficient, Reducible to homogeneous form, Exact differential equations, Linear differential equations of order one, Solution using exact differentials, Bernoulli's differential equations, Applications of Ist order Ordinary Differential Equations, Orthogonal trajectories, Introduction to Mathematical Modelling]; **High Order Differential Equations with Constant Coefficients** [Solution of homogeneous differential equations, Non homogeneous ordinary differential equations, Method of undetermined coefficients, Cases of failure in method of undetermined coefficients, Method of variation of parameters, Cauchy Euler Equation, Solutions of System of linear ordinary differential equations by operator method, Power series method, Solutions about Singular points using the method of Frobenius, Applications of higher order ODEs]; **Partial Differential Equations [**Basic concept of partial

differential equations, solution of PDE and Fundamental Theorem, Solution of homogeneous LPDE by operator method, Method of separating variables (Product Method). Solution of first order, 2nd and higher order LPDE by Product method and examples Boundary value problems with boundary initial conditions, Derivation of one-dimensional wave equation and its solution, Derivation of one-dimensional heat equation and its solution, Heat equation with special cases when initial velocity = 0 and initial displacement $\neq$ 0 and vice-versa, D'Alembert's solution of wave equation].

Lab Outline: Nil

Recommended Books:

Text Books*:*

- Advanced Engineering Mathematics by Kreyszig, 9th Ed, 2006.

Reference Books*:*

- Advanced Engineering Mathematics by Zill & Cullen
- Practical Mathematics Vol-I & II by Toft & McKay
- Introduction to Ordinary Differential Equations by Ross
- Introduction to Partial Differential Equations by Sankara Rao
- Differential Equations by D. G. Zill.

Title of the Course: Advance Engineering Mathematics

Credit Hours: 3-0

Prerequisites: **Advanced Calculus & Transforms and Differential Equations**

Specific Objectives of Course:

To impart knowledge of transformations, partial differential equation, vector algebra & calculus, complex numbers and series for advance level undergraduate engineering subjects and to develop an insight and broaden the outlook for tackling engineering problems arising in daily life.

Course Outline:

Theory of Laplace Transformation and solution of initial value problems; line and surface integrals along with integral theorems; theory of functions of a complex variable and its application.

Lab Outline: Nil

Recommended Books:

Text Book:

- Advanced Engineering Mathematics by Kreyszig, 9th Ed. 2006.

Reference Books:

- Advanced Engineering Mathematics by Wylie Jr
- Further Engineering Mathematics by K. A. Stroud, 3rd Ed.

Physics

Title of the Course: Engineering Physics

Credit Hours: 3-1

Prerequisites: **Intermediate / HSC Level Physics**

Specific Objectives of Course:

To review the fundamental concepts of physics to form basis for engineering subjects taught subsequently.

Course Outline:

Units, Dimensional analysis; Experimental errors; Newton's Laws of Motion and their applications; Circular motion and Gravitation; Escape Velocity; work and Energy; Impulse and Momentum; Rotational Motion; Equilibrium of a Rigid Body; Periodic Motion; Elasticity; Fluid Mechanics; Heat Transfer; Mechanical waves; Reflection and Normal Modes; Sound; Nature and Propagation of Light; Images formed by a Single Surface; Lenses and Optical Instruments; Interference and Diffraction; Radioactive decay, fission and nuclear reactions; Space Environment and its effects; Atoms, Molecules, and Solids; Combination of atoms; bonding forces in solids, Si and Ge crystals and other semi conductor materials; Crystallographic terms, cubic lattices examples; Diamond and Zinc Blend lattices, Energy bands in solids; Direct and indirect semiconductors, effective mass of electron and hole; Intrinsic and extrinsic semi conductors, energy band diagrams, Fermi Dirac statistics, Dopant diffusion technique, critical temperature of extrinsic semi- conductors; Drift of carriers, conductivity and mobility of electrons and holes; Diffusion of carriers, Diffusion and drift of carriers; P-N junction, space charge at a junction; Avalanche Breakdown; P-N junction capacitance; Zener breakdown; Introduction to Quantum Mechanic, Schrodinger Wave Equation; Fermi-Dirac statistics, distribution functions; Hall effect; Photoconductivity;

Lab Outline:

- Determining moment of inertia of common objects
- Determining velocity of sound in air and in brass
- Measuring wavelength of sodium light using spectometer
- Measuring the rotation of plane of polarization of light through sugar solution.
- Studying absorption of radiation in solid material
- Studying the photo electric current as a function of intensity of light
- Determination of the semiconductor type, doping concentration and mobility of carriers.
- Transistors and Integrated Circuits fabrication demonstrations with the help of videos

Recommended Books:

Text Book:

- Physics by Robert Resnick, David Halliday & Krane. 5th Ed (2005).
- Solid State Electronic Devices by Ben G Streetman. 5th Ed (2006)
- Perspectives of Modern Physics by A. Beiser. 6th Ed (2003)

Reference Books:

- University Physics by Thomas D. Young & Freedman 12th Ed (2008)
- University Physics by Sears & Zemansky 4th Ed (1970).
- Circuit Analysis by John R. O'Malley.
- Lectures on Physics by Feyman Lighton & Sand
- Fundamentals of Semiconductors (Physics and Materials Properties) - Peter Y. Yu and Manuel Cardona. 4th Ed (2010)
- Physics of Semiconductor Devices by J. P. Colinge & C. A. Colinge.
- Physical Foundations of Solid State Devices by E. F. Schubert Rensselear Polytechnic Institute Troy, New York 2009.
- Modern Engineering Physics by A. S Vasudeva.

Title of the Course: Engineering Chemistry

Credit Hours: 3-1/2

Prerequisites: **Intermediate / HSC Level Chemistry**

Specific Objectives of Course:

To refresh basic concepts and introduce chemistry related knowledge pertaining to corrosion, engineering materials, paints, polymers, fuels and combustion to prepare students for subjects in engineering domain.

Course Outline:

Electrochemistry [oxidation & reduction, electrochemical series & cells, electrolysis, Galvanic / Voltaic cells, lead storage battery, Zinc-Carbon dry cells, Alkaline batteries, fuel cells, solar / photo cells]; **Corrosion** [types, electrochemical and high temperature corrosion, composition cells, concentration cells, and stress cells, corrosion prevention, metallic & non-metallic coating, and cathode protection, etc]; **Engineering Materials** [crystal & structure of materials, silicon crystal growth, wafer preparation, etc]; Polymers [types, natural, semi-synthetic and synthetic polymers, addition & condensation polymerization, thermoplastic & thermosetting behavior, homo-polymers, copolymers, silicon polymers, electrically conducting polymers, etc]; **Thermo-chemistry** [standard states of elements, enthalpy, heat of formation, heat of reaction, physical state of reactants & products]; **Fuels, Lubricants & Combustion** [classification of fuels, lubricants, gaseous and liquid fuels, criteria for fuel selection, enthalpy of formation & combustion, heating values, adiabatic flame temperature and chemical equilibrium]; **Solution Chemistry** [types of solutions, ionization constant, weak acid / strong acids, pH, buffer solution, and applications in water treatment].

Lab Outline:

- Determining amount per liter of NaOH in the given solution by using standard 0.1N Oxalic acid solution using pH/Potentiometer for its standardization purpose
- To determine the λ max of Manganese and Iron for further spectrophotometer analysis
- To determine the amount of Mn and Cr in KMnO4, CuSO4 or K2Cr2O7 sample solutions using Spectrophotometer
- To determine the amount of Fe in any industrial sample solution of Iron Alloy by spectrophotometer

- Synthesis of a thermosetting polymer (Lucite) and a thermoplastic polymer (Orlon, polythene of PVC) at laboratory scale in required shapes
- To calculate the amount of Copper deposited on cathode in electrolysis of CsSO4 in an electrolytic cell
- Determine the enthalpy of combustion of naphthalene using a bomb calorimeter. Calculate the enthalpy of formation of naphthalene from the enthalpy of combustion using Hess's law
- To determine the amount per litre of Mohr's salt (FeSO4 (NH4)2 SO4 6H2O). Given is standard 0.1N Oxalic acid solution

Recommended Books:

- Chemistry by Michell J. Sienko and Robert A Palne.
- Chemistry Matter and its Changes by James E. Brady and Fred Senese. 5th Ed (2005)
- Applied Chemistry a Text book of Engineers and Technologist by H.D Gesser.4th Ed (2004)
- Engineering Chemistry by S. C. Bhatia
- College Chemistry by J. L. Rosendberg
- Concise Engineering Chemistry by Neetu Geol & Sanjay Kumar
- Engineering Chemistry by S. S. Dara
- Engineering Chemistry by H. K. Chopra & A. Parmar
- Physical Chemistry by Atkins P. W.
- Introduction to Industrial Chemistry by P. J. Chenier
- Advance Inorganic Chemistry by Cotton & Wilkson
- Physical Chemistry by G. W. Castellan
- Quantitative Analysis of Inorganic Chemistry by Vogal

Non-Engineering Domain-Electives

Title of the Course: Statistical Quality Control

(Non-Engineering Domain Elective – I)

Credit Hours: 2-0

Prerequisites: Advanced Engineering Mathematics, Probability and Statistics

Specific Objectives of Course:

To introduce SQC as an important tool of quality control of industry.

Course Outline:

Introduction, Importance of Quality Control and SQC. Introduction to Quality Control, Quality Assurance, Quality System and Statistical Quality Control; Basic concepts of Total Quality Management, Quality Management Systems, Benchmarking, Quality Awards etc; Continuous and Discrete Probability Distributions, Normal Distribution and its importance in sampling, Exponential Distribution, Central Limit Theorem, Bernoulli Trial, Binomial Distribution, Poisson Distribution, Approximations; Analytical Techniques: Moments & their relationships with Mean, Variance, Skew ness and Kurtosis, Expected Value, Properties of mean and variance. Computation of Population and Sample Statistics. Relationships between sample and population statistics; Sources of Variation, Chance /

Assignable Cause variation Variable/Attribute data; Basic Tools of QC [Check sheet, Histogram, Control Chart, Pareto Chart, Cause & Effect Diagram, Scatter Diagram, and Defect Concentration Diagram]; Introduction to Variable control charts ($\bar{X}$ *R, S* Charts) Control chart technique; Steps for $\bar{X}$ & *R* Charts, Establishing the trial control limits; Analysis of pattern of control chart, basic & supplementary criteria, revised control limits; Type I & type II errors; Control limits and specification/tolerances, concept of process capability indexes, C_p & C_{pk} etc; Control Charts for fraction rejected [types of Attributes, Limitations of variable control charts, Limitations of attribute control charts, and Attribute control chart technique]; Steps for *p* chart [Determine the uses of *p* and *np* charts, Determine the sample size, Collect data, and Establish trial control chart: Constant sample size]; Control charts for non-conformities. Determine the uses of *c* and *u* charts, finding limits [Preliminary conclusion from control charts, and Establish revised control chart]; Acceptance sampling: Introduction. Where used? Why used? How used? Limitations of the traditional method, Ideal sampling plan; Single sampling plans, calculation of p_a , The OC Curve; Double sampling plans; Reliability: why emphasis on reliability? reliability of Parallel, Series and Combined systems. Factors on which product reliability depends; and Failure Rate Curve, MTBF, MTTR.

Lab Outline: Nil

Recommended Books:

- Introduction to Statistical Quality Control by Douglas C. Montgomery.
- SQC by E. L. Grant & R. S. Leavenworth.

Title of the Course: **Product Design & Development (Non-Engineering Domain Elective-II)**

Credit Hours: 1-1

Prerequisites: Engineering Management

Specific Objectives of course:

The focus of product design and development is the integration of planning, design and manufacturing functions in creating a new product. The specific topics include development process in organizations, product planning, identifying customer needs, developing product specifications, concept generation, concept selection, concept testing, product architecture, industrial design, design for manufacturing, prototyping and product development economics. The lab portion would include introduction to project management software and a product design and development project.

Course Outline:

Introduction; Development process and organizations; Product planning; Identifying customer needs; Developing product specifications; Concept generation; Concept selection; Concept testing; Product architecture; Industrial design; Design for manufacturing; Prototyping; and Product development economics.

Lab Outline:

Students would be required to handle a comprehensive product development project during the semester consisting of four assignments

Recommended Books:

- Product Design & Development by Ulrich & Eppinger, 2nd Ed, 2000.
- Product Design Methods & Practices by Henry W Stoll
- Developing New Products with TQM by Charles Gevirtz

Note: List of some recommended optional social sciences/management courses is given at annex 'A'.

Engineering Domain
Computing

Title of the Course: Introduction to Computer Programming

Credit Hours: 1-1

Prerequisites: Nil

Specific Objectives of Course:

To teach computer programming (C / C++ / Fortran / VB / or any other high level language).

Course Outline:

Introduction to digital computers, main components and functions Programming languages, Algorithms and flowcharts, Conventions used in writing algorithms and flow charts. Problem specification, basic programming techniques, Pseudo code, Structured programming, compilers, linker, operating systems. Standard input and output devices, variables & expressions, operators, loops, nested loops, functions, macros, arrays and strings, Structures and unions, pointers. File structure, file handling functions, 2-D and 3-D Graphics, data representation, animation, three dimensional projection. Use of subroutine packages. Numerical computation and accuracy considerations. Searching and sorting, Abstraction and its relation to programming; Hardware interfacing

Lab Outline:

Compiling and Linking. Files Used in C Programming Development the Basic Structure of C Program; C Variable declaration, Input/Output, Operators, Comments; Programs for mathematical calculations; Loops; Nested Loops; Decisions; Functions; Arrays; Structure; Unions; Graphics; Hardware interfacing; Projects

Recommended Books:

- Introduction: The Waite Group's Programming for the PC and Turbo C++ Revised Edition by Robert Lafore
- Let Us C By Yashwant Kanethker. How to program C++ by Deitel Deitel
- Object Oriented Programming in C++ by Robert Lafore, 3rd Ed, 2005.
- C++ How to Program by Deitel & Deitel, 3rd Ed, 2002

Title of the Course: **Computer Aided Drafting**

Credit Hours: 0-2

Prerequisites: Nil

Specific Objectives of Course:

To introduce basic concepts and principles of Computer Aided Drafting (CAD) and to prepare student for more advanced uses of computers in CAD/CAM (computer aided manufacturing) operations.

Course Outline:

The course has been designed to provide students with a secure and sufficient background for understanding and using the computers to make 2-D and 3-D engineering drawings. The course had been divided into three parts. In the first part, the students get introduced to the computers. The second part deals with enabling the student to make 2-D drawings with the help of computers. For this purpose Solid Edge / CATIA software is utilized. Students are familiarized with various 2-D drawing commands including the dimensioning commands and advanced editing techniques. Part three is concerned with the drafting of 3-D drawings on computers and for this purpose also Solid Edge / CATIA software is utilized. Students are familiarized with various basic and advanced 3-D drawing commands for enabling them to draft any type of 3-D drawing on the computers in a perfect, precise and efficient manner.

Lab Outline:

Graphical geometry, various types of orthographic drawings, principal, auxiliary and sectional views. Drafting principles, practices; and 2 & 3-D engineering drawing fundamentals, Electronic PCB Design using appropriate computer-aided design tools such as AutoCAD, ORCAD, CATIA, Pspice, Solid Edge, Electronic Workbench, Proteus etc.

Recommended Books:

- Fundamentals of Engineering Drawing by French & Vierck.
- Getting started with Sold Edge Version 12, by Unigraphics Solution Inc
- Fundamentals of Drafting with Auto CAD L. T. by Paul Wallach, Dean Chowenhill & James Cullen
- Solid Edge Help Release 12 manual.
- Solid Edge Tutorials Release 12
- Exercise workbook for beginning AUTOCAD, Cheryl R. Shrock
- Solid Edge on the Web at http:www.solid-edge.com.

Title of the Course: **Numerical Methods**

Credit Hours: 2-1

Prerequisites: Nil

Specific Objectives of course:

To teach the use of computer for the numerical solution of engineering problems.

Course Outline:

Different numerical techniques including Linear iteration Method to find roots of transcendental equations, Newton-Raphson and Regula-Falsi Method to find real roots of transcendental equations, Secant method to find real roots of transcendental equations, solution of simultaneous non-linear equations by Newton-Raphson method, Modified Newton method to solve non-linear simultaneous equations , Lin's Method on roots of polynomial equations, Baristow Technique to find roots of polynomial equations , least square method of fit a polynomial, Least Square method to fit algebraic and transcendental forms, fundamentals of calculus of finite differences, forward backward and central differences. Average and differential operator and relations between them, linear and polynomial interpolation. Gregory-Newton Forward and Backward Difference methods , Stirling and Lagrange Interpolation techniques , divided differences and their application to interpolation ,numerical differentiation using series relations, numerical differentiation using all interpolation, numerical Integration: Trapezoidal Rule, Simpson's Rule and error analysis for both these methods, Gauss Quadrature, numerical solutions of differential equations by Taylor's method, Euler's Method and Modified Euler's Method , Predictor-corrector methods to solve differential equations numerically, Rugne-kutta method , system of differential equations and their numerical solution.

Lab Outline:

This course provides sufficient description of appropriate computer language / software package to solve engineering problems using numerical methods. For the selected computer tool, the labs introduce basic structure of Constants and variables and basic data type, Operators; Arithmetic and relational and math library functions, the for-loop and nested for-lop ,while and do-while loops if-else and nested if statements, Switch and break statement. Nested switch statement, logical operators, Arrays and strings. Sum and product of two matrices, Function sub-programs; their advantages. Emphasis is made on programming applications pertaining to engineering problem like solution of differential equations, interpolation, optimization, roots determination, evaluation of Laplace and Z-transforms etc.

Recommended Books:

- Fundamentals of numerical analysis by Stephen G. Kellison 1st Ed. 1975
- Numerical Methods for Engineers and Scientists (using MATLAB) by A. gilat, V Subramaniam 1st Ed. 2008
- C++ How to program (3rd Ed) by Deitel & Deitel
- Introductory Computer Methods and Numerical Methods by Ralph H. Pennington
- A First Course in Numerical Analysis by Anthony Ralston.
- Methods in Numerical Analysis by K.I. Nielsen
- Numerical Methods and Computers by Shan S. Ku
- Numerical Methods for Engineers by Steven C. Chapra, Raymond P. Canale June 15, 2005.
- Applied Numerical Methods with MATLAB for Engineers and Scientists by S. C. Chapra. 1st Ed. 2005.

Title of the Course: **Computer Aided Instrumentation**

Credit Hours: 1-1

Prerequisites: Nil

Specific Objectives of Course:

This course is meant to prepare student engineers to deal with various types of test and measurement equipment at various stages of their professional life. Students gain an insight into the concepts of measurement methods, direct or indirect and essential to appreciate the problems associated with instrumentations, learn basic characteristics, sources of errors, constructions, behaviour as well as transduction principles of sensors & transducers employed in measurement of various non-electrical parameters commonly encountered in almost every branch of engineering, and become proficient in use, capabilities and limitations of electronic instruments for various measurement applications and to connect them together for proper operation.

Course Outline:

Units & dimensions, dimensional analysis, DC bridge methods, AC bridge methods, sensors & transducers [classification, resistance, reactance change transducers, potentiometric transducers, RTDs, thermistors, hot-wire anemometer, strain-gauge, inductive-type transducers, thermoelectric transducers, semiconductor sensors, piezoelectric sensors, ultrasonic sensors, photo-sensors]; PC based data acquisition, analog instruments, electrodynamometer type instruments, induction type instruments, digital instruments, interference signals, instrumentation transformers. Advanced Instrumentation techniques. Microprocessor based instrumentation systems; interfacing techniques. Data acquisition software and virtual instruments. Intelligent instrumentation systems. It also includes topics related to process of measurement and standards measurement, counters, fluid flow and motion measurement.

Lab Outline:

Experimental portion includes use of measuring instruments like profile projector, screw pitch measuring equipment, interferometer, comparators, non contact RPM sensor and vibration measurement equipment. PC based data acquisition and analysis experiments include automated dimensional measurement quality control equipment, thermocouples, strain gauge load cell, accelerometer, pressure transducer flow meters and coordinate measurement machine. .Lab outlines may be developed by institutions keeping in view their laboratory facilities must be aimed at integrating theory of measurements with engineering practices to demonstrate common mechanical measurements. A typical instrumentation can be built using LabView software and common variables like temperature, pressure, displacement etc can be measured by interfacing sensor to computer using data acquisition card.

Recommended Books:

- Mechanical Measurements by Thomas G beckwith, Roy D Marangoni, & John H Lienhard V, 5th Ed. 1993.
- Lab view Essential Techniques GUI by David J Ritter, 2002.
- Principles of Electronic Instrumentation & Measurement by Howard Berlin and Frank Gaetz

- Modern Electronic Instrumentation & Measurement Techniques by William D. Cooper.
- Instrumentation for Engineering Measurements by James W. Dally 2nd Ed.

Engineering Foundation

Title of the Course: Engineering Statics

Credit Hours: 3-0

Prerequisites: Applied Algebra and Calculus

Specific Objectives of Course:

To understand general principles of bodies at rest and at equilibrium under the action of forces.

Course Outline:

This course covers properties of forces, moments, couples and resultants, analysis of two dimensional problems, application of equilibrium principles to simple trusses and to frames and machines, special topics of beams and friction as well as selected applications. Bending and shear force diagrams for beams and introduction to three dimensional trusses.

Lab Outline: Nil

Recommended Books:

- Engineering Mechanics by J. L. Meriam & L. G. Kraige 4th Ed. 1999.
- Engineering Mechanics by Irving H Shames 4th Ed.
- Engineering Mechanics (Statics) by R. C. Hibbeler.

Title of the Course: Engineering Dynamics

Credit Hours: 3-0

Prerequisites: **Engineering Statics**

Specific Objectives of Course:

To develop the ability to visualize physical configurations in terms of real materials, actual constraints and practical limitations which govern the behaviour of machines and structures.

Course Outline:

The course has been divided into four parts. The first part (Kinematics of Particles) deals with a number of ways in which the motion of a particle is generated. Part two (Kinetics of Particles) is concerned with the three basic methods, force-mass-acceleration, work-energy, and impact. In the third part (Kinematics of Rigid Bodies) the equations of relative velocity and relative acceleration are encountered; emphasis is placed jointly on solution by vector geometry and solution by vector algebra. Part four (Kinetics of Rigid Bodies) covers the basic equations which govern all categories of plane motion.

Lab Outline: Nil

Recommended Books:

- Engineering Mechanics (Dynamics) By J. L. Meriam & L. G. Kraige
- Engineering Mechanics (Dynamics) by R. C. Hibbeler.
- Engineering Mechanics by Higdon and Stiles.

Title of the Course: Engineering Circuit Analysis-DC Circuits

Credit Hours: 2-½

Prerequisites: Physics and Applied Algebra & Calculus

Specific Objectives of Course:

To provide an introduction to the fundamentals of circuit analysis with emphasis on fundamental quantities and components of electricity, basic electricity laws and network theorems.

Course Outline:

This is the first course in Electrical Engineering and forms the basis of all subsequent courses in Avionics Engineering. It introduces fundamental quantities and components of electricity, nodal and mesh analysis methods, basic laws and network theorems (Kirchoff's laws, voltage/current division rules, source transformation, linearity, superposition and maximum power transfer theorems) for resistive circuits, theory of inductors and capacitors along with their response. Analysis of linear RLC circuits is covered at the end of the course.

Lab Outline:

An introduction to Safety, Electrical Grounding, Electric Shock Hazards and Controls, and Inadvertent activation of electrical appliances and machines, Ignition of flammable and combustible materials and explosives, Ohm's Law, Kirchoff's Voltage Law, Kirchoff's Current Law, Nodal & Mesh analysis, Superposition Theorem, Thevenin's / Norton's Theorem, and Series and Parallel RC, RL and RLC Circuits.

Recommended Books:

- Fundamentals of Electric Circuits by M. N. O Sadiku 3rd Ed.
- Engineering Circuit Analysis by James W Nilsson
- Introduction to Electric Circuits by Richard C Dorf
- Engineering Circuit Analysis by Willian Hayt & Kemmerly
- Principle of electric Circuits 7th Ed. By Thoms L. Floyd.

Title of the Course: Engineering Circuit Analysis-AC Circuits

Credit Hours: 2-½

Prerequisites:

Engineering Circuit Analysis-DC Circuits, Differential Equations, Transforms and Complex Numbers

Specific Objectives of Course:

To provide a foundation in analog signal processing required for further study in digital signal processing, communications, control, and electronics.

Course Outline:

Analysis of linear RLC circuits excited by time-varying voltage and currents, RLC circuit representation and solution using differential equations, classical, Phasor and Laplace transform techniques. Mutual inductance, power and resonance are also discussed, Transformer, Poly-phase circuit configurations, Phasor diagrams and two-port network theory is also included.

Lab Outline:

Oscilloscope Familiarization, Measurement of Time using Oscilloscope, Transient Response analysis, Sinusoidal Steady State Analysis, Frequency Response of RLC Circuit, Parallel RLC Circuit, Design and Simulation of RL & RC and RLC circuit with ac excitation on Pspice.

Recommended Books:

- Engineering Circuit Analysis by William H. Hayt Jr. & Jack E. Kemmery
- Fundamentals of Electric Circuits by M. N. O Sadiku 3rd Ed.
- Introduction to Electric Circuits by Richard C. Dorf
- Principle of electric Circuits 7th Ed. By Thoms L. Floyd.

Title of the Course: Digital Systems-Logic Design & Devices

Credit Hours: 3-½

Prerequisites: Nil

Specific Objectives of Course:

To provide an introduction to the fundamentals of combinational & sequential logic circuits.

Course Outline:

This course lays down the foundations required for a digital system design. The course deals with the fundamentals of Combinational and Sequential Logic Design. Some of the VERILOG HDL topics are included to give this course an edge in digital design techniques. Programmable Logic Devices such as RAMs and ROMs and PLDs are also included.

Lab Outline:

Truth tables of the different gates, combinational circuit (using 2 and/or 3 input gates), combinational logic binary circuit with BCD code as input and Excess-3 code at output, BCD to 7-segment decoder, 2-to-4 line decoder, state table of J-K flip flop, and sequential circuit using J-K flip flops.

Recommended Books:

- Logic and Computer Design Fundamentals, by Morris Mano and Charles Kime 2nd Ed. 2005
- Digital Design Principles And Practices, by John F. Wakerly
- Verilog H. D. L. Synthesis by Samir Palnitkar
- Digital Electronics Principle and Application by roger L Tokheim, 6th Ed. 2002
- Digital Logic Fundamentals by R. D. Tocci.

Title of the Course: **Electronics-Devices & Basic Circuits**

Credit Hours: 3-½

Prerequisites: **Engineering Physics and Engineering Circuit Analysis – AC Circuits**

Specific Objectives of Course:

To introduce semiconductor devices and analysis & design of analog circuits.

Course Outline:

Introduction to electronics, semiconductor diodes, special purpose diodes, diode applications, bipolar junction transistor, transistor operation, types of transistor, biased transistor, transistor biasing configurations: common emitter, common base, common collector, field effect transistor, FET biasing techniques: common drain, common source and common gate, fixed bias and self bias configurations, differential amplifiers using BJT and FETs, feedback, and signal and waveform generation.

Lab Outline:

Basic properties of Junction Diodes, clipper, voltage regulator under loaded and unloaded conditions, and rectification properties of semiconductor diodes. Design and Simulation of a capacitor coupled CE amplifier on Pspice, and analyze transistor amplifier in common collector configuration (Emitter follower).

Recommended Books:

- Microelectronic Circuits by Adel S. Sedra & Kenneth C. Smith 5th Ed. 2004.
- Electronics Circuits Discrete & Integrated By Schilling and Belove
- Electronic Devices by Thomas Floyd.

Title of the Course: **Electromagnetic Field Theory**

Credit Hours: 2-½

Prerequisites: Engineering Physics, Differential Equations, and Advance Engineering Mathematics

Specific Objectives of Course:

To introduce fundamentals of electromagnetic filed theory for understanding and analyzing electromagnetic phenomenon.

Course Outline:

Vector algebra, coordinate systems and transformations, vector calculus, electrostatics [electric fields, electric fields in material spaces, and electrostatic boundary value problems], steady magnetic field (magneto-static) [magnetic forces, materials, and devices].

Lab Outline:

Coulomb's law, equipotential lines of electric fields, force of an electric charge in a homogeneous electric field, Field Plotting, capacitance of a plate capacitor, measuring the charge with parallel and series connection of capacitors, magnetic field for a straight conductor, circular conductor loops, air coil, and a pair of coils in

the Helm-holtz configuration, force acting on current-carrying conductors in the field of a horseshoe magnet, homogeneous magnetic field, and an air coil.

Recommended Books:

- Elements of Electromagnetics by Matthew N. O. Sadiku 2nd Ed.
- Field and Wave Electromagnetic by David K. Cheng 2nd Ed.
- Engineering Electromagnetics by William H. Hayt 2nd Ed.
- Electronic Communication Systems by George Kennedy 2nd Ed.
- Electromagnetic Waves and Radiating Systems by Edward C. Jordin & Keith G. Balmain
- Engineering Electromagnetism by Hammond P. & Sykulski J. K., Oxford University Press

Title of the Course: Signals and Systems

Credit Hours: 3-½

Prerequisites: Elements of Applied Algebra and Calculus, Advanced Calculus and Transforms, and Advanced Engineering Mathematics

Specific Objectives of Course:

To introduce fundamentals of signals and systems with emphasis on LTI continuous and discrete time systems, Fourier series, Fourier Transform, Laplace Transform and Z-transform.

Course Outline:

Types of signals, signal representation and models, system characterization, time domain analysis, LTI systems, both continuous time (CT) and discrete time (DT), convolution sum/integral, causality and stability, frequency domain representation and analysis, Fourier Series (FS), Fourier Transform (FT), Laplace Transform (LT) and Z-Transform, continuous-time filters, sampled continuous-time signals, frequency domain representation and analysis of signals and systems.

Lab Outline:

Analysis of signals, Periodicity of the signals, Demonstration of Convolution, filter design, analog-to-digital converters, Demonstration of effect of Zero and Poles on System Performance, Fourier Transformation, and signal sampling using different parameters.

Recommended Books:

- Signal & Systems by Oppenheim and Wilsky with Nawab. 2nd Ed. 1997
- Discrete time signal Processing by Oppenheim and Schaffer 2nd Ed.
- Signals and Systems by Simon Haykin and Barry Van Veen, 2nd Ed. 2004
- Signals and Systems by Rodger E. Ziemer, William H. Tranter and d. Ronald Fannin, 4th Ed. 2002.
- Introduction to Signal & Systems by Oppenheim
- Signals and Systems - An Introduction by Leslie Balme

Title of the Course: **Analysis and Design of Control System**

Credit Hours: 2-½

Prerequisites: Signals & Systems

Specific Objectives of Course:

To provide an introduction to the classical control systems for developing mathematical models to design electromechanical systems using transfer function, root locus and frequency response design techniques.

Course Outline:

This course is aimed at building a comprehensive foundation for the analysis and design of continuous-time as well as discrete-time systems using classical techniques. The course covers system modelling, system responses, control system characteristics, stability analysis, root locus analysis and design, and frequency response analysis and design.

Lab Outline:

DC Motor Modeling, Time Response Specifications, Disturbance Rejection, Steady State Error, Controller Design (Time Domain), Controller Design (Freq Domain), Effects of sampling, Discrete-Time Controller Design, and Demonstration of Control Algorithms for Inverted Pendulum.

Recommended Books:

- Feedback Control Systems by Phillips and Harbor (3rd Ed)
- Modern Control Systems by Richard C. Dorf (5th Ed)
- Control System Design using MATLAB by Bahram Shahian & Michael Hassul
- User's Guide for The Student Edition of MATLAB by Duane Hanselman & Bruce Littlefield
- Control System Engineering by Norman S. Nise. 3rd Ed.
- Automatic Control Engineering by Francis H. Raven 5th Ed.
- R.C. Dorf, R. H. Bishop, Modern control Systems 10th d., Prentice Hall 2005
- G.F. Franklin, J.D. Powell, A. Emami Naeini, Feedback Control of Dynamic Systems, 4th Ed.
- G. C. Goodwin, S. F. Graebe, M. E. Salgado, Control system Design, Prentice Hall 2001.

Title of the Course: **Probability & Statistics**

Credit Hours: 3-0

Prerequisites: Advanced Calculus and Transform

Specific Objectives of Course:

To develop understanding of fundamentals of probability including various probability distributions and laws of statistics and elementary statistical techniques to effectively analyze scientific data.

Course Outline:

Set theory, basic concepts of probability, conditional probability, independent events, Baye's formula, discrete and continuous random variables, distributions and density functions, probability distributions (binomial, Poisson, hyper geometric, normal, uniform and exponential), mean, variance, standard deviations, moments and moment generating functions, linear regression and curve fitting, limits theorems, stochastic processes, first and second order characteristics, applications.

Lab Outline: Nil

Recommended Books:

- Introduction to Statistics by Walpole
- Modern elementary statistics by John E. Freund
- Probability and its engineering uses by T. C. Fry.
- Elementary statistics by P. A. Games & G. R. Klaro.
- Probability and statistics by Nestellor, Rourke and Thomas
- Statistics Methods for Quantity Control by Jardino, Mecfarlano & Greensted.
- Statistics in theory and practice by Conner & Morrell.
- Introduction to Mathematical Statistics by P. G. Hoel.
- Basic statistical methods for scientists and Engineers by Adams & Nevile.
- Introduction to Theory of Statistics by Uspensky.

Major Based Core (Breadth)

Title of the Course: Electronics-Analogue & Digital Integrated Circuits

Credit Hours: 3-½

Prerequisites: Electronics – Devices & Basic Circuits

Specific Objectives of course:

To provide an insight into analysis and design of analog electronic circuits emphasizing amplifiers that find extensive application in computers, control systems, digital instrumentation, communications, and radars, etc.

Course Outline:

Differential amplifiers in both its bipolar and FET forms followed by various output stages; frequency response of amplifiers; feedback analysis with focus on practical circuit applications of negative feedback; stability problems in feedback amplifiers; introduction to analogue integrated circuits (bipolar and MOS) leading to analysis of a 741 operational amplifier; and design of filters, tuned amplifiers, and oscillators.

Lab Outline:

Frequency response of MOSFET and BJT amplifiers, Basic and improved current mirrors, Basic BJT differential amplifiers, Common-mode and differential mode operation of differential pair, frequency response of a differential amplifier, feedback topologies, multistage amplifiers, and response of 741 Operational Amplifier.

Recommended Books:

- Microelectronic Circuits By Adel S. Sedra & Kenneth C. Smith
- Analysis and Design of Analog Integrated Circuits by Grey and Meyer

- Electronic Devices & Circuits by Theodore F. Bogart Jr., Jeffrey S. Beasley

Title of the Course: Digital Systems-Microprocessors (Architecture, Interfacing & Programing) & Microcontrollers

Credit Hours: 3-1

Prerequisites: **Digital Systems-Logic Design & Devices**

Specific Objectives of Course:

To develop understanding of principles and techniques of machine-level programming, use of computers for real-time data acquisition and control of input-output devices.

Course Outline:

Introduction to Intel family microprocessors, instruction set architecture (ISA), fetch and execution cycles, assembly language programming, hardware model, read/write cycles, exception/interrupt processing, memory systems, I/O devices, DMA, interfacing to memory and I/O devices, analogue-to-digital and digital-to-analog converters, introduction to PIC / 8051 microcontrollers and C-51 language programming.

Lab Outline:

Demonstration of Program Counter, Adder / Subtractor unit, Accumulator, design and implementation of simple microcontroller based circuits like timers, counters, LCD display, square wave generator etc.

Recommended Books:

- Digital Computer Electronics By Malvino Brown
- Microprocessors and Interfacing Programing and Hardware By Douglas V. Hall Second Edition
- The 8051 Micro controllers by L Scott Mackenzie
- The Intel Microprocessors 8086/8088, 80186, 80286, 80386, 80486, Pentium, and Pentium Pro Processor ARCHITECTURE, PROGRAMMING, AND INTERFACING BY Barry B. Brey Fourth Edition
- An Introduction to Object Oriented Design in C++ - Jo Ellen Perry
- Programming 8 BIT – PIC – Micro – Controllers by Martin P. Bates
- An Introduction to Programing the Microchip PIC in CCS C by Nigel Gardener.

Title of the Course: Transmission Lines and Waveguides

Credit Hours: 2-½

Prerequisites: Engg. Physics, Engg. Circuit Analysis-AC Circuits, Differential Equations, Electromagnetic Field Theory

Specific Objectives of Course:

To provide an introduction to the fundamentals of electromagnetic wave propagation in both guided structures and open media and application of this basic knowledge to the analysis and design of transmission lines and wave-guide systems.

Course Outline:

Topics related to the propagation of plane Electromagnetic Waves in unbounded medium i.e. time-varying fields including Faraday's law of EM induction, displacement current; Maxwell's equations; EM boundary conditions; wave equations; time harmonic fields etc. Applications of the Maxwell's equations to wave propagation in transmission lines, which includes transmission line parameters, SWR, Power, Smith chart and techniques of matching the transmission lines. Rectangular waveguides including Transverse Magnetic (TM) & Transverse Electric (TE) modes, power transmission & attenuation and modes of excitation of a waveguide.

Lab Outline:

Demonstration of Faraday's law, Phasors, Plane waves, and polarization. Reflection, Refraction and transmission of microwaves in free space. Reflection from a metal plate and a dielectric plate. Propagation in a transmission line. Attenuation & dispersion in a transmission line**. T**ransmission line behaviour using different terminations. Measurement of amplitude of standing waves and frequency of microwave signal in a waveguide. Familiarization with Smith chart and its use in evaluating a load impedance.

Recommended Books:

- Elements of Electromagnetics by Matthew N. O. Sadiku (2nd Edition)
- Field and Wave Electromagnetic by David K. Cheng (2nd Edition)
- Engineering Electromagnetics by William H. Hayt (2nd Edition)
- Electronic Communication Systems by George Kennedy (2nd Edition)
- Electromagnetic Waves and Radiating Systems by Edward C. Jordin & Keith G. Balmain

Title of the Course: **Modern Control System**

Credit Hours: 2-½

Prerequisites: Probability & Statistics, and Analysis & Design of Control Systems

Specific Objectives of Course:

This course builds on the classical control system analyses and design methods learnt by the student. In this course the students are introduced to the modern control system design using state space methods.

Course Outline:

Introduction to state space methods, State variables, state differential equations, transfer functions, root locus, Kalman filtering, discrete time stability, fundamental notions of controllability and observability for state variables models as well as PID controller design in state-space will be covered. The students are also introduced to advanced topics including optimal and digital controller design principles.

Lab Outline:

State space controller design in MATLAB, Design of a Full-State Feedback Control System using Pole-Placement, Magnetic Ball Control System Modeling and Simulation using SIMULINK, Random Signal Filtering in MATLAB, Kalman Filter

Design and Simulation, Controller Design (Discrete Time System), Case study of any digital flight control aerospace vehicle.

Recommended Books:

- Modern Control systems by Richard C. Dorf & Robert H Bishop 5th Ed.
- Modern control Design using MATLAB & Simulink by Ashish Tewari
- Feedback Control Systems by Charles Phillips & Royce D. Harbor 4th Ed.
- Control Systems engineering, by Norman S. Nise 3rd Ed.
- The student Edition of MATLAB by Math Work Inc.
- Flight Dynamics Principles by M V Cook.

Title of the Course: Analogue & Digital Communications

Credit Hours: 3-1
Prerequisites: Signals & Systems, Advanced Calculus & Transforms, Probability & Statistics

Specific Objectives of course:

To introduce fundamentals of analogue and sampled data communication systems with emphasis on system architectures, signal-to-noise ratios, and bandwidth requirements of amplitude, frequency, pulse code modulation techniques.

Course Outline:

Various techniques of modulation and demodulation of analog signals, Signal-to-noise-ratio (SNR) in analogue AM and FM systems, digital transmission methods for analogue signals, discrete pulse and carrier wave modulation schemes, Bit error rate performance of various digital communication systems, and Spread Spectrum systems.

Lab Outline:

AM, FM, and SSB Communication. Phase Lock Loops, Frequency Synthesizers, Sampling & Holding, Time Division Multiplexing, Pulse Code and Delta Modulation, and Frequency Division Multiplexing.

Recommended Books:

- Modern Digital and Analogue Communication Systems, 3rd Edition by B. P. Lathi
- Introduction to Communication System by Ferral G. Stremler
- Analog and Distal Communication Systems by Martin S. Roden
- Principles of Communication Systems by Herbert Taub and Donald L. Schilling
- Communication System by Simon Haykin

Title of the Course: Electro-Mechanical Systems

Credit Hours: 2-½

Prerequisites: Engineering Circuit Analysis-AC & DC Circuits, and Differential Equations

Specific Objectives of Course:

To provide an introduction to the fundamentals of power circuits, transformers and electromechanical systems with an emphasis on rotating machines and transformers.

Course Outline:

Principles of electromagnetic energy conversion; introduction and operation of DC motors and their characteristics; servos and synchros; commutation and speed control; transformers for single and polyphase circuits; principle of operation of AC generators and their characteristics; efficiency and losses; construction, operation and characteristics of polyphase induction motors; synchronous AC motors & Universal motors; fault location in machines and selection of machines, stepper motors

Lab Outline:

Transformer open circuit and short circuit test, efficiency and regulation of single phase transformer, DC motor starting and running at variable speed, No load magnetization curve of self and separately excited DC generators, Regulation and characteristics of self excited and separately excited dc generators, DC motor speed characteristics, and DC motor torque Characteristics.

Recommended Books:

- Electric Machinery Fundamentals by Stephen J. Chapman 4th Ed. 2005.
- Electric Machines: Theory, Operation, Applications, Adjustment and Control by Charles I Hubert
- Circuit Devices and Systems by Ralph J Smith
- Direct & Alternating Current Machinery by Rosenblatt and Friedman

Major Based Core (Depth)

Title of the Course : **Antenna Engineering**

Credit Hours: 2-½

Prerequisites: Electromagnetic Field Theory, Transmission Lines & Waveguides, Advanced Engg Mathematics

Specific Objectives of course:

To introduce, in a unified manner, the fundamental principles of antenna theory, parameters, principles, arrays, and to apply them to the antenna analysis and measurement.

Course Outline:

Physical principle of radiation mechanism, parameters, radiation properties of a wire antenna, theory and design of linear wire, loop, arrays and reflector antennas, and antenna measurement facilities and techniques.

Lab Outline:

Demonstration of Antenna radiation, transmission and reception using videos and Antenna Trainers. Introduction to Antenna modelling software e.g. MMANA. Antenna propagation realization and plotting of Gain/Directivity of two horn antennas. Simulation of Dipole Antenna in MMANA. Demonstration of end-fed vertical antenna. Study the effect of change in effective length of an antenna. Analysis of Effects of Perfect Ground on Linear Wire Antennas using appropriate software.

Recommended Books:

- Antenna Theory Analysis and Design by C. A. Balanis, John Wiley & Sons.
- Antenna Theory and Design by Stutzman
- Field and Waves Electromagnetics by David K Cheng. 2nd Ed. 1983.
- Antenna for all Application by John D. Kraus 3rd Ed.

Title of the Course: Microwave Engineering

Credit Hours: 2-½

Prerequisites: Engineering Physics, Transmission Lines & Waveguides

Specific Objectives of Course:

Introduction of the fundamentals of microwave devices with emphasis on distinctive features of their construction and understanding of the differences between electrical characteristics in lower frequency bands and RF / Microwave frequencies.

Course Outline:

Introduction of microwaves devices applicable to radar and Communication systems. Study of passive and active microwave devices including solid state devices, Klystron, Magnetron, TWT and Twystrons as microwave oscillators and amplifiers.

Lab Outline:

Solid state power amplifier measurements, Operation of Magnetron & TWT, radiation pattern comparison of small and large loop antenna using software simulations, simulation and analysis of uniform linear arrays and parasitic arrays.

Recommended Books:

- Microwave Devices & Circuits by Samuel Y. Liao
- Passive and Active Microwave Circuits by J. Helszajn
- Electronic Communication Systems by George Kenned
- Microwave Engineering by David Pozar. 2nd Ed. 1998.
- Understanding Microwave by Allan W. Scott 1993.
- Microwave Transistors and Ampliflers by Guillermo Gonzales 2nd Ed. 1996.
- Microwave Made Simple by W. S. Cheung 1985.

Title of the Course: Radar Systems

Credit Hours: 2-½

Prerequisites: Electromagnetic Field Theory, Transmission Lines & Waveguides, Microwave Engineering, Communication – I, Analysis & Design of Control Systems, Probability & Statistics

Specific Objectives of Course:

To provide an introduction to the fundamentals of radar systems with emphasis on pulse radar, CW, FMCW, MTI, MTD, target tracking, electronic scanned antenna, and radar performance in active environment, ESM, ECM and ECCM at system level.

Course Outline:

Basics of what radar is all about and what it can do, basic radar equation and important factors which influence range performance of radar, basic concepts of probabilistic detection used to analyse the performance of any radar, principle and applications of CW and FMCW radar, basic concepts of analogue/digital MTI, Adaptive MTI and pulse Doppler radar, various tracking radar techniques, electronically steered phased array antenna and side lobe cancellation, radar performance in wartime environment and electronic warfare, basic principles of electronic support measures, noise jamming, frequency agility, stealth technology and deceptive/expandable ECM.

Lab Outline:

Introduction to Pulsed Radar and Range-Delay Relationship, Radar Range Equation, Targets and Radar Cross Section, Frequency Modulated CW Radar, Tracking Radar and Manual Tracking of a Target, Basic Principles, Operation, and adjustments of Phased Array Antenna, Spot Noise Jamming and Burn-Through Range, Frequency Agility and Barrage Noise Jamming Radar.

Recommended Books:

- Introduction to Radar System, 2nd Edition by M. I. Skolnik.
- Understanding Radar Systems by Simon Kigsley and Shaun Que

Title of the Course: Data Communication & Networks

Credit Hours: 2-½

Prerequisites: **Analogy and Digital Communication**

Specific Objectives of Course:

To provide a unified overview of the broad field of data and computer communications emphasizing on its basic principles and topics of fundamental importance including basic background, design, and evaluation skills in telecommunication and communication networks.

Course Outline:

Introduction to data communication, protocols and architectures, transmission media, data link control, multiplexing, circuit switching and packet switching, ATM and frame relay, routing in switched networks, high speed LANs, wireless LANs, internet protocols, transport protocols, and network security.

Lab Outline:

Understanding Networking Utilities; Using packet sniffer to capture network traffic and decode header info; Developing a simple TCP client/server program; Developing a concurrent server to work with several clients simultaneously; Client/server communication using datagram sockets; Client/server Implementation of Data Link Layer.

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Recommended Books:

- Data and Computer Communications, by William Stallings 8th Ed.
- Computer Networks, by Larry Peterson, Bruce Davie, 3rd Ed.

- Computer Network by A S Tanenbaum. 4th Ed. 2002.
- Data Communications and Networking by Behroze A. Forouzan, 4th Ed.

Title of the Course: **Avionics System Design,**

Credit Hours: 2-2

Prerequisites: Analysis & Design of Control Systems, Guidance, Navigation & Control, Applied Aerodynamics.

Specific Objectives of course:

This course presents an advanced coverage of the issues involved in design of an avionics suite of an airborne platform. The course contents lead the student through one iteration of conceptual design cycle of a complete avionics suite to meet mission specific requirements using a wide range of avionics sub-systems. The course covers the essential ingredients of avionics system design including data buses, displays and power systems with emphasis on aircraft interfaces and avionics system architecture and fitting of avionics systems into aircraft as well as the integration of avionics system hardware and software.

Course Outline:

A balanced combination of lectures and work-sessions creates an appreciation of the intricacies of integrating sophisticated avionics sub-systems like INS, FMS, HUD/HDD, HMD, RWR, mission computer, radar, radio communication, instruments, autopilot etc. The students are introduced to design standards followed by the avionics industry worldwide. The major design steps include the determination of sub-system specifications, selection of sub-systems and design of avionics architecture with consideration to system performance, power consumption, layout, cost, EMC/EMI, maintainability, redundancy, testability, weapon delivery and man-machine interface. Since avionics systems design is a compromise of all the engineering disciplines, students learn the design trade-off in order to meet mission specific requirements. The course also introduces important topics like man-machine interaction, aerodynamics and aircraft control, fly-by-wire flight control, guidance and navigation, pitot-static air data systems, autopilots and flight management systems, avionics interfaces (data buses, crew displays, power, maintenance, physical interfaces), unmanned air vehicles, Doppler and altimeter radars, and mapping & multimode Radars.

Lab Outline:

To be developed by the institutions specific to the projects assigned to the students and appropriate for the laboratory facilities available

Recommended Books:

- Introduction to Avionics Systems (2nd Edition) by R. G. Collinson
- Avionics Navigation Systems by Myron Kayton and Walter R. Fried
- Aircraft Electricity & Electronics By K. Eismin Mc-Graw Hill. 1994.
- Digital Avionics System by Cary R. Spitzer, 2nd Ed. 2000.
- Military Avionics Systems by Ian Moir and Allan Seabridge 2006.
- Fight Dynamics Principles by M. V. Cook 2007.
- Tactical and Strategic Missile Guidance by Paul Zarchan 3rd Ed. 1997.

- Avionics Systems Design by John R. Newport, CRC Press, 1994.
- Principles of Avionics by Albert Helfrick 2002.
- The Avionics Handbook by Cary R. Spitzer, 2000, CRC Press.
- Aircraft Communication & Navigation Systems by Mike Tooley and David Wyatt, 1st ed. 2007.

Title of the Course: Operational Amplifier Circuit Design

Credit Hours: 2-½

Prerequisites: Electronics – Devices & Basic Circuits and Analogue & Digital Integrated Circuits

Specific Objectives of Course:
To provide design and application oriented understanding of operational amplifier as a circuit element.

Course Outline:
The topics discussed in this course include: Linear properties of operational amplifiers, stability using Bode diagrams, linear and non-linear applications of operational amplifiers including oscillators, filters, voltage regulators, current-voltage converters, precision instrumentation amplifiers, log / antilog amplifiers, PLL etc.

Lab Outline:
Balancing input offset of Operation Amplifier; Linear Inverting Operational Amplifier; Linear Non-Inverting Operational Amplifier; Summing Amplifier; Integrator; Differentiator; Wien -Bridge oscillator; Waveform generation using 555 timer.

Recommended Books:
- Basic Operational Amplifiers and Linear Integrated Circuits By Thomas L. Floyd
- Electronic Devices by Floyd (6th Edition)
- Introduction to Operational Amplifiers by Luces M. Faulkenberry

Title of the Course: Emerging Aviation Technologies

Credit Hours: 1-0

Prerequisites: Radar Systems, Guidance, Navigation & Control, Antenna Engineering

Specific Objectives of course:
To present an advanced coverage of latest trends in different subjects related to aviation technologies particularly the aviation electronics.

Course Outline:
Topical coverage includes antenna design tools, microstrip technologies, instrumentation buses, network centric warfare, soft computing techniques, LPI radar, air traffic management, fiber optics, software radios, directed energy, information theory & coding, Electromagnetic interference, fly by wire concepts, nano- technologies, wireless communication and stealth technology.

Lab Outline: Nil

Recommended Books:

- Microwave Transistor Amplifiers Analysis and Design (2nd Edition) by Guillermo Gonzalez
- Microstrip Design & Applications by Gunta Kompa
- Applied Electronics Instrumentation & Measurement by David Buchla
- Network Centric Warfare: Developing & Leveraging information superiority by David S. Alberts, John J Garstka, Frederick P Stein
- Tactical Communications for Digitized Battlefield by Ryan & Frater
- Wireless Communication by Andrew Goldsmith
- Introduction to Micro Electro-Mechanical Systems Engineering by Nadim Maluf and Kirt Williams
- Detecting and Classifying LPI Radar by Phillip Pace
- Introduction to Fiber Optic Systems by John Powers
- EMC for Product Designers by Tim Williams
- Flight Dynamics Principles by M V Cook
- Future Test System Architectures by Grant Drenko, IEEE Autotestcon 2004
- Dawn of the e-bomb by Michael Abrams, IEEE Spectrum November, 2003
- The Electromagnetic Bomb – a weapon of Electrical Mass Destruction by Carlo Kopp
- Future Test System Architectures by Grant Drenko, IEEE Autotestcon 2004.

Inter-Disciplinary Engineering (Breadth)

Title of the Course: **Thermodynamics of Propulsion**

Credit Hours: 3-0

Prerequisites: Engg Physics

Specific Objectives of Course:

To understand and develop the essential background and know how of thermodynamics.

Course Outline:

Zeroth law, First law and its applications to various systems, physical properties of pure substances, use of property tables, PVT relations, equations of state for ideal gases, Second law and its results, reversible and irreversible processes and cycles, and concept of entropy and its uses. Applications of the concepts are focused on the Closed Thermodynamics System. An introduction to the Open Systems and their applications are also included.

Lab Outline: Nil

Recommended Books:

- Engineering Thermodynamics, An Introductory Textbook by J. B. Jones / G. A. Hawkins, Second Edition, John Wiley & Sons Inc, 1986

- Thermodynamics " by Kenneth Wark
- Applied Thermodynamics " by T. D. Estop / McKonkey
- Fundamentals of Engineering Thermodynamics by M J Moran & H. N. Shapiro
- Engineering Thermodynamics by J. B. Jones/G A Hawkins. John Wiley & Sons Inc. 2nd Ed
- Mechanics & Thermodynamics of Propulsion by P. D. Hill & C. R. Peterson, Wesley, NY,
- Rocket Propulsion Elements by Geroge P. Suton, Oscar Biblarz, John Wiley, NY,

Title of the Course: Applied Aerodynamics-Basics

Credit Hours: 1-½

Prerequisites: Engineering Dynamics

Specific Objectives of course:

To introduce aerodynamics to Avionics Engineering students.

Course Outline:

The course includes definitions and concepts related to the hydrostatic equation and Standard Atmosphere. It deals with both incompressible and compressible flows and the application of continuity, momentum and energy equations in their simplified forms. The course includes an introduction to wind tunnel design and compressibility effects in aerodynamic flows. The differences between laminar and turbulent flows are also highlighted in this course

Lab Outline: Nil

Recommended Books:

- Introduction to Flight by J. D. Anderson, Jr.
- Gas Dynamics by E. A John
- Fundamentals of Aerodynamics" by JD Anderson, Jr

Title of the Course: Applied Aerodynamics-Airplane Aerodynamics (Performance, Stability & Control)

Credit Hours: 2-0

Prerequisites: Applied Aerodynamics-I, Engineering Dynamics, Thermodynamics

Specific Objectives of course:

To build on the knowledge of basic aerodynamics and extends it to airplane aerodynamics.

Course Outline:

Concepts related to flow over airfoils and compressibility effects on lift and drag generation; differences between infinite and finite wings; simplified analysis of aircraft performance and various key concepts related to static stability of aircraft.

Lab Outline: Nil

Recommended Books:

- Introduction to Flight by J. D. Anderson, Jr., 6th Ed, 2007
- Gas Dynamics by E. A. John
- Aeroplane Aerodynamics by Domasch, Sherby and Conally.
- Fundamentals of Aerodynamics by J. D. Anderson, Jr,
- Aircraft performance, Stability and Control Vol-1 by James D. Lang.

Title of the Course: **Introduction to Aerospace Engineering**

Credit Hours: 0-1

Prerequisites: Nil

Specific Objectives of Course:

To provide basic understanding of aircraft and its systems to the engineering students.

Course Outline:

The course covers flight controls, aircraft construction, principles of jet reaction, flight instruments, electrical system and armament. Flight control studies deal with aerodynamics and aircraft control surfaces. Aircraft construction includes basic structure of aircraft, landing gears, hydraulic, pneumatic and fuel systems. The topic 'principle of jet reaction' includes thrust and power, factors effecting thrust, compressors and jet propulsion devices. The study of aircraft instruments includes flight, engine auxiliary instruments. The electrical system deals with power supply, power generation and electrical components. Armament systems study includes aircraft ejection system, fundamentals of bombs and firearms, principle and construction of ammunition and explosives.

Lab Outline: Nil

Recommended Books:

To be decided by institutions offering the course.

Title of the Course: **Workshop Technology-I Basic Machines & Tools**

Credit Hours: 0-1

Prerequisites: Nil

Specific Objectives of Course:

To introduce students with the materials, machining tools, and techniques used in mechanical system manufacturing workshops.

Course Outline:

Introduction to common lab practices, importance & observance of safety rules & regulations, familiarization with common hand tools and their working, familiarization with operation of some basic machines, different operations on lathe machines

(turning, tapering, boring, drilling, threading, etc), chassis fabrication, working with wood & usage of wooden tools, and different types of welding.

Lab Outline:

- Introduction to Lathe, its parts & accessories and basic operations
- Assignment of main project work piece
- Final design and technical drawings
- Development of manufacturing process sheets
- Introduction milling machine, its parts & accessories, basic operation
- Basic milling operations, indexing and gear cutting
- Introduction to shaper machine, its parts & accessories, basic operation
- Introduction to Electro-Discharge Machine (EDM), its accessories and basic operation

Recommended Books:

- Modern Metal Working by John R. Walker, 2004 Edition
- Introduction to Technology of Machine Tools by S. F. Krar A. R. Gill & Peter Smid, 6th Edition (2004)
- Technology of Machine Tools by S. F. Krar 3rd & 4th Ed.
- Machine Shop by Wagener And Arthur
- Shop Theory by Henry Ford Trade School
- Modern Metal Working by John R. Walder
- Process Selection : From Design to Manufacture by K. G. Swift and J. D. Booker
- Engineering Design Graphics : Autocad R12 by James H. Earle

Title of the Course: Workshop Technology-II Advanced Machines & Tools

Credit Hours: 0-1

Prerequisites: Workshop Technology –Basic Machines & Tools

Specific Objectives of Course:

To familiarize with the working capabilities and construction of main machine tools. used in aerospace mechanical system manufacturing.

Course Outline:

Use and applications of machine tools in manufacturing engineering, non-traditional machine techniques, Shaper machine and Milling machine, computer-age machining techniques, CAD/CAM on CNC milling machine, proper selection of cutting speeds, feeds and depth of cut, tool's signature for various operations, electronic fabrication skills, soldering & de-soldering skills & techniques, PCB fabrication & assembling techniques, soldering & de-soldering of components & connectors etc, cable making techniques using special tools e.g. crimping etc, wiring, cabling & looming techniques vis-à-vis aircraft and other systems, familiarization with Quick disconnects, and basic electrical trouble-shooting techniques.

Lab Outline:

Lab Safety Practices; Classifying Metals; Measurement; Layout Work; Hand tools; Hand Tools that Cut; Drills and Drilling Machines; Fasteners; Sawing and Cutoff Machines; Hand Threading; Gas Welding; Shielded Metal Arc Welding; Other Welding Processes; Soldering and Brazing; Grinding.

Recommended Books:

- Modern Metal Working by John R. Walker, 2004 Ed.
- Introduction to Technology of Machine Tools by S. F. Krar A. R. Gill & Peter Smid, 6th Edition (2004)
- Technology of Machine Tools by S. F. Krar 3rd & 4th Ed.
- Machine Shop by Wagener And Arthur
- Shop Theory by Henry Ford Trade School
- Modern Metal Working by John R. Walder
- Process Selection : From Design to Manufacture by K.G. Swift and J. D. Booker
- Engineering Design Graphics : Autocad R12 by James H. Earle.

Title of the Course: **Manufacturing Processes and CNC Machines (Inter-disciplinary Engineering Elective-I)**

Credit Hours: 0-1

Prerequisites:

Specific Objectives of Course:

To introduce students to different manufacturing processes and working of CNC machines.

Course Outline:

This course introduces the students to manufacturing processes like sand & metal casting, forging, cold forming, extrusion, spinning, sheet metal processes, broaching, heat treatment and powder metallurgy. Finally manufacturing process sheets are discussed. The Lab portion of the course introduces the students to general purpose ISO codes for programming CNC machines with specific emphasis on CNC Lathe and CNC milling machines. Students are familiarized with interface of available milling and lathe simulation software. Basic turning and milling operations are practiced in class assignments for which students are required to generate code to be run using simulation software. Students are also provided opportunity to run codes on machines available in CNC Lab.

Lab Outline: As instructed by instructor.

Recommended Books:

- Software Manual, Turning for Windows, INTELYS
- Software Manual, Milling for Windows, INTELYS of Engineering Drawing" by French & Vierck.

- Process Selection : From Design to Manufacture by K.G. Swift and J. D. Booker.

Title of the Course: **Engineering Drawing**
(Inter-disciplinary Engineering Elective-II)

Credit Hours: 0-1

Prerequisites:

Specific Objectives of course:

To teach students the skill of sketching engineering drawings of various objects using orthogonal views and prepare them for subsequent use of computer aided drafting.

Course Outline:

This course consists of a series of lectures and class room exercises designed for familiarizing the students with the basic concepts of Engineering Drawing. It includes a brief account of the various types of drawings with main emphasis on Orthographic Drawings which are the most widely used mode of technical communication. It includes detailed exercises on graphical geometry and then continues with progressive practice in making and understanding various types of orthographic drawings. The topics covered include Principle Views, Auxiliary Views and Sectional Views.

Lab Outline: As instructed by instructor.

Recommended Books:

- Fundamentals of Engineering Drawing" by French & Vierck, 4th Edition.

Title of the Course: Advanced Digital System Design
(Inter-disciplinary Engineering Elective-III)

Credit Hours: 3-1

Prerequisites: Digital System Design and Applications

Specific Objectives of course:

To prepare the students to design HDL-based digital systems; use Finite State Machines for the design of control units of sequential systems; test designs using verification techniques like test benches
Implement these designs on an FPGA or CPLD prototyping board;
Understand and assess timing parameters of finished designs

Course Outline:

Background and fundamentals of VHDL: Importance of HDLs, HDL based design cycle. System representation in HDL: Design units and signals—Entity, Architecture, packages. Specifications of system interface: System I/O ports, generic clauses; HDL constructs for describing system behaviour: Non-logic data types, expressions and operators, simple signal assignments, constants; Processes: Structure and execution of processes; Combinational systems with VHDL: Review of combinational logic, combinational building blocks in VHDL—

decoders, encoder, MUX, DeMUX and arithmetic circuits. Combinational design examples—barrel shifter, priority encoder etc. Sequential building blocks with programmable logic devices: Review of sequential circuits and the architecture of programmable devices. Architecture of CPLDs and FPGAs; Sequential design examples—LFSR, complex counters; More constructs of VHDL: Multiple processes in architectures, concurrency, signal assignments, drivers and signals. Direct entity instantiation, components and configuration. Delay types in VHDL. Test benches: Test benches for combinational and sequential designs. Hierarchical design: implementation of hierarchical systems using structural constructs of VHDL. Synthesis: Discussion of non-synthesizable constructs and code. Design implementation issues using synthesis, simulation tools/packages. Design of Sequential synchronous systems—FSMs: Introduction to FSMs and their design. Translating state diagrams into VHDL. Concept of data path and control unit. Sequential synchronous system with multiple interactive FSM. State encoding schemes, unused states, initializing an FSM. Timing considerations and problems with synchronous systems : Timing specification of synchronous systems and CPLDs/FPGAs; Setup and hold time and margins, combinational and sequential delays; Clock skew and clock gating, asynchronous inputs; Practical modeling examples : Some complete practical systems will be developed from specification to programming on the FPGA. Examples may include digital alarm clock, microprocessor slice etc..

Lab Outline:

Laboratory work will be based on synthesis and simulation tools. Lab sessions will be used to familiarize the students with different features of HDL and to design combinational and sequential building blocks and systems.

Recommended Books:

- Mark Zolinski. Digital System Design with VHDL, 2nd Ed.
- E. O. Hwang. Digital Logic and Microprocessor Design with VHDL (2006)
- Pedroni. Circuit Design with VHDL, 2004.

Title of the Course: Introduction to Microwave Circuit (Inter-disciplinary Engineering Elective-IV)

Credit Hours: 2-½

Prerequisites: Microwave Engineering

Specific Objectives of course:

The objective of this course is to introduce the students to the microwave circuits..

Course Outline:

Principles, analyses, and instrumentation used in the microwave portion of the electromagnetic spectrum. Wave theory in relation to circuit parameters. S parameters, couplers, discontinuities, and microwave device equivalent circuits. RF amplifier design, Stability, Stabilization and Gain, Matching networks, attenuators and phase shifters, microwave sources, optimum noise figure and maximum power designs. Microwave filters and oscillators.

Lab Outline: As instructed by the instructor.

Recommended Books:

- Introduction to Microwave Circuits by Robert J. Weber, IEEE Press 2001
- RF and Microwave Circuit Design by Stephen E. Maas, 1998 Artechouse Inc.
- Microwave Transistor Amplifiers: Analysis and Design by Guillermo Gonzalez.

Curriculum for ME/MS (Avionics Engineering)

ME/MS (Avionics Engineering)-Programme Structure

The ME/MS Avionics Engineering program was thoroughly discussed, revised and agreed upon in the meeting. It was noted that the ME/MS Avionics Engineering program should be designed as the next higher professional degree for BE Avionics graduates. For ME/MS minimum credit hours required shall be 30. Following is the distribution of total credit hours.

Component	Credit Hours
Core Courses (Minimum)	09
Elective Courses (Maximum)	15
Thesis	06
Total	**30**

ME/MS (Avionics Engineering)-Program Objectives

The objectives of ME/MS Avionics Engineering program is to produce graduates, who:

- Are well-educated and successful professionals, technically well prepared for their subsequent assignments, duties and responsibilities as Avionics engineers in public as well as private sector organizations.
- Apply foundational scientific concepts and sound engineering principles to efficiently and effectively advance technological capabilities in the country.
- Have experience in conducting and documenting an independent investigation of a problem pertaining to Avionics Engineering.
- Professionally communicate technical issues, their solutions and results.
- Continue to pursue lifelong multidisciplinary learning as professional engineers.

ME/MS (Avionics Engineering)-Learning Outcomes

To achieve the programme educational objectives, following learning outcomes for ME/MS (Avionics Engineering) have been definitized:-

(a) Ability to design a system to meet desired needs.

(b) Ability to function on multidisciplinary teams.

(c) Ability to identify, formulate and solve engineering problems.

(d) Knowledge of contemporary issues.

(e) Ability to use advanced techniques, skills, and modern engineering tools necessary for engineering practice.

Scheme of Studies
ME/MS (Avionics Engineering)

ME/MS Avionics Engineering is proposed in three specialities, ie Control Systems Engineering, Communication Systems Engineering and Microwave Engineering. The award of ME/MS degree requires successful completion of 24 credit hours of graded post-graduate level courses and successful defence of 6 credits hours of thesis research. The specialty wise requirements for the MS degree are as follows:

MS in Control Systems Engineering

Eligibility for Admission:

- BE / BSc Engineering (Electrical / Electronics / Avionics / Computer / Telecomm / Aerospace / Mechanical / Mechatronics)
- Minimum GPA 2.5/4.00 or 60% marks
- GRE General / NTS (min 50% score) or alternative examination stipulated by Higher Education Commission of Pakistan

Course Requirements:

Core Courses: At least three of the following core courses are required.

Course Title	Credits		Course Title	Credits
Linear Systems Theory	3		Flight Dynamics & Control	3
Optimal Control	3		Random Processes	3
Adaptive Control	3		Advanced Engineering Mathematics	3
Non-Liner Systems	3			

Elective Courses: A maximum of five elective courses are to be selected. Following courses are electives for the Control Systems Engineering specialty.

Course Title	Credits	Course Title	Credits
Linear Multivariable Feedback Control Systems	3	Adaptive Filter Theory	3
Robust Control	3	Navigation Systems	3
Soft Computing Systems	3	Missile Guidance	3
System Identification	3	Information Theory	3
Instrumentation & Measurement for Aerospace Applications	3	Software Engineering	3
Digital Signal Processing	3	Design and Analysis of Algorithms	3
Stochastic Systems	3	Optimization	3
Detection & Estimation	3	Image Processing	3
Embedded System Design Fundamentals	3	Power Electronics	3
Neural Networks	3	Advanced Topics in Control Engineering	3
Array Signal Processing	3	Avionics Integration	3
Micro-Electromechanical-Systems	3	Engineering Management	3

MS Thesis (06 credits) is compulsory.

MS in Communication Systems Engineering

Eligibility for Admission:

- BE / BSc Engineering (Electrical /Electronics / Avionics / Computer / Telecomm)
- Minimum GPA 2.5/4.00 or 60% marks
- GRE General / NTS (min 50% score) or alternative examination stipulated by Higher Education Commission of Pakistan

Course Requirements:

Core Courses: At least three of the following core courses are required.

Course Title	Credits	Course Title	Credits
Digital Signal Processing	3	Communication Networks	3
Random Processes	3	Wireless Communications I	3
Digital Communications	3	Advanced Engineering Mathematics	3

Elective Courses: A maximum of five elective courses are to be selected. Following courses are electives for the Communication Systems Engineering specialty.

Course Title	Credits	Course Title	Credits
Linear Multivariable Feedback Control Systems	3	Principles of Real-Time Computing	3
Soft Computing Systems	3	Design and Analysis of Algorithms	3
Stochastic Systems	3	Optimization	3

Detection & Estimation	3	Image Processing	3
Embedded System Design Fundamentals	3	Advanced Antenna Engineering	3
Adaptive Filter Theory	3	Semiconductor Device Technology	3
Navigation Systems	3	Analog IC Design (Bipolar)	3
Information Theory	3	Analog IC Design (MaS)	3
Wireless Communications II	3	Advanced Topics in Communications	3
Software Engineering	3	Model based Software Testing	3
Neural Networks	3	Avionics Integration	3
Array Signal Processing	3	Micro-Electromechanical-Systems	3
Engineering Management	3	Advanced Computer Networks	3

MS Thesis (06 credits) is compulsory.

MS in Microwave Engineering

Eligibility for Admission:

- BE / BSc Engineering (Electrical / Electronics / Avionics / Computer / Telecomm)
- Minimum GPA 2.5/4.00 or 60% marks
- GRE General / NTS (min 50% score) or alternative examination stipulated by Higher Education Commission of Pakistan

Course Requirements:

Core Courses: At least three of the following core courses are required.

Course Title	Credits	Course Title	Credits
Electromagnetic Field Theory	3	Microwave Engineering	3
Transmission Lines and Waveguides	3	Microwave Electronic Devices	3
RF and Microwave Circuit Design	3	Advanced Engineering Mathematics	3

Elective Courses: A maximum of five elective courses are to be selected. Following courses are electives for Microwave Engineering specialty.

Course Title	Credits	Course Title	Credits
Soft Computing Systems	3	Advanced Antenna Engineering	3
Embedded System Design Fundamentals	3	Semiconductor Device Technology	3
Navigation Systems	3	Analog IC Design (Bipolar)	3

Software Engineering	3	Analog IC Design (MOS)	3
Design and Analysis of Algorithms	3	Power Electronics	3
Optimization	3	Advanced Topics in Microwave Engineering	3
Microwave Design	3	Avionics Integration	3
Array Signal Processing	3	Micro-Electromechanical-Systems	3
Modern Radar Systems	3	Engineering Management	3

MS Thesis (06 credits) is compulsory.

Details of Courses
for ME/MS (Avionics Engineering)

Course Title	Course Description
Linear Systems Theory	The course covers following topics. Linear spaces and linear operators. Bases, subspaces, eigenvalues and eigenvectors, canonical forms. Linear differential and difference equations. Mathematical representations: state equations, transfer functions, impulse response, matrix fraction and polynomial descriptions. System-theoretic concepts: causality, controllability, observability, realizations, canonical decomposition, stability, introduction to optimal control and the Kalman filter.
Linear Multivariable Feedback Control Systems	Control design concepts for linear multivariable systems. Review of single variable systems and extensions to multivariable systems. Purpose of feedback. Sensitivity, robustness, and design tradeoffs. Design formulations using both frequency domain and state space descriptions. Pole placement/observer design. Linear quadratic Gaussian based design methods. Design problems unique to multivariable systems.
Optimal Control	The course covers following topics. Euler-Lagrange formulation; Hamilton-Jacobi approach; Pontryagin's minimum principle; Systems with quadratic performance index; Second variation and neighbouring externals; Singular solutions; numerical solution techniques.
Non-Linear Systems	The course covers following topics. Introduction to the analysis and design of nonlinear systems and nonlinear control systems. Stability analysis using Lyapunov, input-output and asymptotic methods. Design of stabilizing controllers using a variety of methods: linearization, absolute stability theory, vibrational control, sliding modes and feedback linearization.
Flight Dynamics & Control	The course covers following topics. Static stability and trim; stability derivatives and characteristic longitudinal and lateral-directional motions; and physical effects of the wing, fuselage, and tail on aircraft motion. Flight vehicle stabilization by classical and modern control techniques; time and frequency domain analysis of control system performance; and human-pilot models and pilot-in-the-loop controls with applications. Parameter sensitivity; and handling quality analysis of aircraft through variable flight conditions. Introduction to nonlinear flight regimes.
Robust Control	Introduction to Lebesgue and Hardy functional spaces,

Course Title	Course Description
	linear operators and norms; time and frequency domain representations of linear systems, internal stability, performance measures and their limitations; model reduction and approximation by balanced realization; classical method of robustness in frequency domain, Bode's gain and phase relations, sensitivity functions; different explicit models of system uncertainty, unstructured uncertainty and small gain theorem, robust stability and robust performance; structured uncertainty and mu-synthesis; H-2 and H-infinity optimal control; H-infinity loop shaping; Gap metrics, nu-gap metrics and extended loop-shaping design;
Adaptive Control	Dynamic System Models, Signal Measures, lyapunov Stability, I/O stability, Adaptive parameter Estimation, Adaptive state feedback control, Continuous time MRAC, discrete-time MRAC, Indirect Adaptive Control, Multivariable Adaptive Control
Soft Computing Systems	Fuzzy Sets, Fuzzy rules and reasoning, Fuzzy inference systems, least squares methods for system ID, derivative based optimization, derivative free optimization, Adaptive Networks, Supervised learning NN's, Learning from reinforcement, unsupervised learning, Neuro fuzzy interfaces, data clustering algorithms, neurofuzzy control
System Identification	The mathematical foundations of System Identification, Non-parametric techniques, Parameterizations and model structures, Parameter estimation, Asymptotic statistical theory, User choices, Experimental design, Choice of model structure
Neural Networks	This course will be an introduction to the basic neural network architectures and learning rules. Emphasis will be placed on the mathematical analysis of networks and learning rules, and on the application of neural networks to certain engineering problems in pattern recognition, signal processing and control systems. The course will incorporate necessary background material (such as linear algebra, optimization and stability), while including extensive coverage of performance learning, like the Widrow-Hoff rule and backpropagation. Several enhancements of backpropagation, such as the conjugate gradient and Levenberg-Marquardt variations, will be discussed. Simple building blocks will be used to explain associative and competitive networks, including feature maps, learning vector quantization, and adaptive resonance theory. Recurrent associative memory networks, such as the Hopfield network, will also be presented.

Course Title	Course Description
Instrumentation & Measurement for Aerospace Applications	Principles and Elements of Instrumentation and Measurement Systems, Review of Random Processes, Inertial Force Sensors, Inertial Rotation Sensors, Applications of rate gyros, Coriolis Angular rate sensors, Fibre optics gyros, Ring Laser Gyros, Filtering Estimation and Aiding
Random Processes	Introduction to probability and random processes. Topics include probability axioms, sigma algebras, random vectors, expectation, probability distributions and densities, Poisson and Wiener processes, stationary processes, autocorrelation, spectral density, effects of filtering, linear least-squares estimation, and convergence of random sequences.
Digital Signal Processing	Introduction to digital signal processing of continuous and discrete signals. The family of Fourier Transforms including the Discrete Fourier Transform (DFT). Development of the Fast Fourier Transform (FFT). Signal sampling and reconstruction. Design and analysis of digital filters. Correlation and spectral estimation. Estimators of second order properties of random processes: nonparametric and model-based techniques of spectral estimation
Avionics Integration	This course will cover Microprocessors (DSP/controllers), Real time operating systems Vx-works, Android and RT-Linux), Multi-thread programming , Scheduling schemes, Programming Communication buses (MLT-ST-1553, ARINC 429, CAN and MODBUS) , general design con-siderations /techniques and simulation of test systems via Hardware-In-The-Loop methodology. Embedded systems/ Avionics system Components Communication Buses / Direct link. Real time operating systems User requirement generation, Design and development considerations.
Stochastic Systems	This course covers review of random processes & linear systems, modelling of physical systems by stochastic differential & difference equations. Other topics included are, Analysis of systems whose inputs are stochastic processes, Spectral factorization, parametric optimization,. Minimum variance control, State estimation of continuous-time and discrete-time systems, Linear stochastic control theory.
Detection & Estimation	Brief Review Of Probability& Statistics, Detection Theory: Hypothesis Testing, Decision Criteria, Basic Concept Of Estimation: Maximum Likelihood, Maximum A Posteriori Estimator, Linear Estimation In Static Systems, Method Of

Course Title	Course Description
	Least Squares, Recursive Least Squares, Linear Dynamic System With Random Inputs, State Estimation In Discrete Time Linear Dynamic Systems, Estimation For Kinematic Model, Kalman Filter Applications, Extended Kalman Filter And Applications, Adaptive Estimation And Manoeuvring Target Tracking, Input Estimation And Manoeuvre Detection, Variable State Dimension Approach, Multiple Model Algorithms, Interacting Multiple Model Algorithms For Manoeuvring Targets, Multiple Sensor Data Fusion.
Embedded System Design	Embedded system design fundamentals as well as reconfigurable logic design and implementation using a hardware description language are covered in this course. Experiencing various micro-controllers and microprocessors, participants discover hardware, software and firmware design trade-offs, tool chains, and best practices in current embedded systems development. Real-time operating system topics will be considered to further emphasize embedded hardware-software impacts. Numerous hands-on laboratory projects are provided to reinforce lecture concepts. A final project will integrate course topics into an embedded system design based on an intellectual property (IP) core implemented in a reconfigurable logic package and driven by application code loaded from either the development platform or on-board firmware.
Communication Networks	This course covers physical layer communications, Link layer protocols, Introduction to queuing theory, Higher layer protocols: TCP, IP and ATM, Routing algorithms, Flow control, Local Area Networks and multiple access, High performance switches and routers, Wireless Networks, Optical Networks and WDM.
Digital Communications	This course covers Sampling, Pulse Code Modulation, Pulse Amplitude Modulation, Pulse Position Modulation, Time Division Multiplexing, Digital Pass band Modulation: Gram Schmidt orthagonalization procedure, Geometric representation of signals, Noise: Additive Gaussian white and colored noise, multiplicative noise , Receivers: Optimal Receiver in AWGN (ML Receiver), sub-optimal Receivers, Matched Filter Receiver, receiver performance, performance comparison of modulation schemes, Probability of Error, Coherent modulation schemes: BFSK, BPSK, Binary Amplitude shift keying: BASK, M-ary modulation schemes, Performance comparison of modulation schemes in AWGN, Non-Coherent Digital Modulation Schemes, Non-Coherent ML Receiver, Non-Coherent BPSK, Non-Coherent BFSK, Non-Coherent BASK, Synchronization and Symbol Timing

Course Title	Course Description
	Recovery, Digital Communication through band limited channels: ISI, Optimum receiver with ISI, Equalization.
Navigation Systems	Introduction to navigation science, coordinate frames and transformations, review of relevant concepts from systems theory and random processes, discrete linear and nonlinear Kalman filtering techniques, the global positioning system, inertial navigation, navigation examples and case studies
Missile Guidance	Tactical Missile Guidance: Proportional navigation; Important closed-form solutions and their utility; Method of Adjoints: Analysis of missile guidance systems using adjoints; Noise Analysis: Simulating noise, stochastic adjoints; Monte Carlo results; Proportional Navigation and Miss Distance: Useful design relationships for rapid guidance system sizing; Digital Noise Filters: Digital noise filter properties and system performance; Advanced Guidance Laws: Deriving optimal guidance laws without optimal control theory; Kalman Filters and the Homing Loop: Combining Kalman filtering and optimal guidance and optimal guidance techniques; Endoatmospheric Ballistic Targets: Speed, Re-entry angle, Ballistic coefficient; Extended Kalman Filtering: Performance comparison of linear, linearized, and extended Kalman filters; Other Forms of Tactical Guidance and Tactical Zones: Beam rider, command to line-of-sight guidance plus drag and acceleration factors.
Information Theory	The course covers, Entropy rates of stochastic processes. Maximum entropy and Burg's Theorem. Kolmogorov complexity. Information theory and statistics. Stein's Lemma. AEP. Network information theory. Slepian-Wolf Theorem. Broadcast channel. Multiple access channel capacity. Optimal investment and information theory. Universal portfolios and universal data compression.
Wireless Communications I	This course covers Analog and digital modulation, Propagation, shadowing, fading, Radio trunking, Multiple access schemes: FDMA, TDMA, CDMA, Cellular communications, Diversity Equalization, Channel coding, Wireless systems and, standards (1G/2G/3G systems), Speech coding, OFDM, Multi-user detection, space time coding, smart antenna, software radio
Wireless Communi-cations II	Wideband and narrowband channel models, Digital modulation in wireless channels, Diversity (both receive and transmit), Multicarrier modulation and orthogonal frequency division multiplexing (OFDM), Capacity of fading channels, Adaptive modulation, Coding and interleaving in fading

Course Title	Course Description
	channels, Spread spectrum and RAKE receivers, Time, frequency division multiple access (FDMA, TDMA)l, Code division multiple access (CDMA), Multiple access channels and their channel capacities, Advanced topics in multiple access such as multiuser detection, multiuser OFDM, and multiuser diversity as time allows.
Software Engineering	The goal of software engineering is to control the quality of software by following engineering principles during development. In the practical aspect of this course, the use of object-oriented programming, design patterns, refactoring and extreme programming will be discussed. As a graduate level course, the other aspect of this course focuses on automatic techniques that analyze software artefacts and thus facilitate the engineering process. Through course projects, students will acquire hands-on experience on analyzing software.
Model based Software Testing	The course covers following topics. Fundamentals of software testing; Test generation using finite state models, State charts, Timed automata, Constraint Logic, Petri nets, Z, Combinatorial design, and others; Test adequacy assessment using black box and white box criteria; Industrial applications of model based testing. Students will be required to form small teams of two or three, preferably interdisciplinary, and make in-class presentations based on a selected topic in model based testing. The work of each team will be reviewed by the instructor and other teams.
Principles of Real-Time Computing	The primary purpose of this course is to present an overview of real-time computing. Basic concepts, terminology, and problems of real-time computing are introduced. The constraints of real-time computing are used to contrast real-time applications from applications that are not real-time. The course focuses on software solutions to real-time problems. Issues that are addressed include scheduling, specification of system requirements and design, real-time software architectures, languages and operating systems for real-time computing, real-time problems in a distributed processing system, and hardware-software interfaces.
Design and Analysis of Algorithms	The course covers following topics. Computational models and techniques for analyzing the time and space complexity of algorithms. The design and analysis of recursive and non-recursive algorithms for searching, sorting, set operations,

Course Title	Course Description
	graph algorithms, matrix multiplication, etc. NP-Complete problems.
Optimization	An introduction to various methods of obtaining the extremum (minimum or maximum) of a non-dynamical system and the use of these methods in real-life applications. Computational methods for nonlinear optimization; unconstrained optimization. Constrained optimization; linear programming; simplex method for solving linear programs; Lagrange's conditions, the Karush-Kuhn-Tucker (KKT) conditions, Least squares, Penalty methods, Practical aspects of optimization.
Image Processing	The course is presented in three units. Foundations: the review of continuous-time and discrete-time signals, and spectral analysis; design of finite impulse response and infinite impulse response digital filters; processing of random signals. Speech processing: vocal tract models and characteristics of the speech waveform; short-time spectral analysis and synthesis ; linear predictive coding. Image processing: two dimensional signals, systems, and spectral analysis; image enhancement; image coding; image reconstruction. The laboratory experiments are closely coordinated with each unit. Throughout the course, the integration of digital signal processing concepts in a design environment is emphasized.
Adaptive Filter Theory	Theory and applications of adaptive filtering in systems and signal processing. Iterative methods of optimization and their convergence properties: transversal filters; LMS (gradient) algorithms. Adaptive Kalman filtering and least-squares algorithms. Specialized structures for implementation: e.g., least-squares lattice filters, systolic arrays. Applications to detection, noise cancelling, speech processing, and beam forming.
Advanced DSP	Estimators of second order properties of random processes: nonparametric and model-based techniques of spectral estimation, characterization of output statistics for nonlinear systems, time-frequency representations. Performance evaluation using asymptotic techniques and Monte Carlo simulation. Applications include speech processing, signal extrapolation, multidimensional spectral estimation, and beam-forming.
Electromagnetic Field Theory	The course covers following topics. Vectors, Coulomb’s Law, Electric Field, Gauss’s Law, Scalar Potential, Conductors in Electrostatic Fields, Electrostatic Energy,

Course Title	Course Description
	Electric Multi-poles, Boundary Conditions at Surface Discontinuity, Electrostatics in the presence of Matter, Special Methods in Electrostatics, Electric Currents, Ampere's Law, Magnetic Induction, Integral form of ampere's law, Vector Potential, faraday's Law of Induction, Magnetic Energy, Magnetic Multi-poles, magnetism in the presence of matter, Maxwell's Euations, and Scalar and Vector Potentials.
Transmission Lines and Waveguides	The course covers following topics. Plane waves, Polarization, Laws of Reflection and Refraction, Energy Relations, Waveguides (Fields in Bounded Regions), Circuits and Transmission Lines.
RF and Microwave Circuit Design	Topics include resonators, filters, detectors, mixers, amplifiers, and microwave systems. There are student design projects for a micro-strip resonator, micro-strip low pass filter, and a high dielectric constant coaxial resonator bandpass filter based upon the Microwave Office software package and use of MathCad at student's option.
Microwave Engineering	Properties of waveguides, striplines, and micro-strips. Scattering parameters. Butterworth and Chebyshev impedance transformers. Microwave couplers, cavities, and Fabry-Perot resonators. Periodic structures. Microwave filter design. Faraday rotation and non-reciprocal devices.
Microwave Electronic Devices	The course covers following topics. Theory and design of passive and active microwave components and monolithic integrated circuits including: microstrip, lumped inductors and capacitors, GaAs FETs, varactor and mixer diodes, monolithic phase shifters, attenuators, amplifiers and oscillators. Experimental characterization of the above components using network analyzer, spectrum analyzer, power and noise meter
Analog IC Design (Bipolar)	This course is devoted to the study of analog circuits realized in bipolar technology, with a focus on applications such as trans-impedance amplifiers, and broadband amplifiers for networking and communications. The course begins with a consideration of device operation and the modelling needed to support both the hand analysis and computer simulation needed for design. Basic circuit building blocks and cascaded multistage amplifiers will be analyzed. The analysis and design of feedback circuits is a key component of the course.
Advanced Antenna Engineering	Antenna concepts, linear wire antennas, linear arrays, aperture and horn antennas, printed-circuit radiators,

Course Title	Course Description
	frequency-independent antennas, and measurement techniques.
Semiconductor Device Technology	The principle of operation, device physics, and analytical numerical, and circuit device models for semiconductor devices, such as bipolar junction transistors, metal-semiconductor junctions and transistors, hetero-structure junctions and transistors. Selected advanced semiconductor devices, such as novel microwave devices, are also introduced. Prerequisite: SDM-I or equivalent.
Microwave Design	This course presents advanced techniques applicable to the design of RF amplifiers and oscillators and emphasizes advanced theory and design techniques. Considerable emphasis is placed on microstrip implementation of UHF and microwave circuits. In the latter part of the course, commercially available computer-aided design and analysis software packages are introduced and used to complete the second design problem.
Analog IC Design (MOS)	Analysis, design and applications of modern analog circuits using integrated bipolar and field-effect transistor technologies. Provides the student with a working knowledge of the basic circuits used in modern analog integrated circuits and techniques for analysis and design.
Power Electronics	Introduction to the fundamental operating principles of power conditioning circuits that are currently being used to effect power flow from ac to dc and vice versa. Emphasis is on the relationship between form and function of these circuits. Circuits discussed will include ac/dc line-commutated converters, dc/dc converters, dc/variable frequency converters, resonant converters, and ac/ac converters. Computer simulations will be used as a part of the course work.
Array Signal Processing	Array signal processing belongs to the general domain of space-time processing as it uses multiple sensors, arranged in a specific geometric arrangement, to acquire multiple versions of a signal. These multiple versions of the signal are processed jointly to estimate the location of the signal source. For multiple signal sources, we can determine and track the locations of these sources. This course covers Basics of Array Signal Processing: Wavefields in Open Space, Spatial Signal Processing, Transmit Beam forming Arrays, Receiver Antenna Arrays, Uniform Linear Arrays: Theory of Array Signal Processing, Source Localization using Frequency Wave-number Spectrum, Narrowband and Wideband, Subspace Methods, Mutual Coupling and

Course Title	Course Description
	Correlation, Beam-forming and Main Beam Steering, Null Placement; Implementation of Array Signal Processing Systems: Signal Processing Errors, Array Element Failure, Ill-conditioned Matrices; Applications of Array Signal Processing, Arrays for RADAR Applications, Arrays for SONAR Applications, Arrays for Biomedical Applications, Arrays for Wireless Communications
Adv Topics in Control Engg	Current topics of interest in control systems. This course may be repeated for credit.
Adv Topics in Communications	Current topics of interest in communications. This course may be repeated for credit.
Adv Topics in Microwave Engg	Current topics of interest in Microwave Engineering. This course may be repeated for credit.
Adv Topics in DSP	Current topics of interest in Digital Signal Processing. This course may be repeated for credit.
Adv Engg Mathematics	Theory of linear algebra, eigen values, eigen vectors, orthogonality. Vector calculus, Gauss's divergence theorem, Stokes's theorem, Cartesian tensors, Variational calculus, Linear programming, Constrained and unconstrained Optimization, Integral Transforms (Laplace, Fourier, Mellin, Hankel, Z-Transform),Numerical Integration are introduced.
Micro-Electromechanical-Systems	This course on Micro-Electro-Mechanical Systems (MEMS) is designed for graduate (i.e. Masters and PhD) students pursuing higher degrees in Avionics and Aerospace Engineering. The course is designed to systematically teach the specifics of MEMS to an interdisciplinary audience. The design, materials, and fabrication issues related to the MEMS field will be covered in this course by employing concepts from both the electrical and mechanical engineering domains and by incorporating evolving microfabrication technology. Frequent examples and problems will be covered to develop sound concepts and understanding about different MEMS based sensing and actuation mechanisms. A number of real life applications of MEMS, with a significant focus on aviation related applications, will be discussed. **Text Book:** Foundations of MEMS by Chang Liu, Prentice Hall, 2005, 1st Ed
Modern Radar Systems	This course covers the design of modern radar systems. Main topics include, electronic beam scanning, Doppler filtering, pulse compression, radar signal processing,

Course Title	Course Description
	advanced detection algorithms, solid-state transmitter, radar networking and radar target tracking.
Engineering Management	Introduction to engineering management: management of new products, management of manufacturing processes, management of the linkages between new products and manufacturing processes. Current theories, concepts and techniques are stressed, using a combination of readings, cases and guest speakers. The objective of this course is to examine issues relevant to growing technology businesses, developing products, improving processes, and leading technology based organizations.

RECOMMENDATIONS

The NCRC discussed different aspects of the curricula of BE/BS & ME/MS Avionics Engineering and makes the following recommendations:-

1. The core courses be made compulsory in all Universities of Pakistan and a set of electives may be chosen to fulfil complete curriculum requirement. The electives proposed by the committee may not be considered as mandatory. Universities may introduce additional electives to meet their own peculiar requirements on the recommendations of their own Board of Studies. Similarly the text books, as proposed, are also meant as a guideline only.

2. At most of the public / private sector universities / colleges, laboratories need improvements. The education in the field of engineering, particularly in Avionics Engineering cannot be imparted without practical experiments and hands-on practices. Special attention and additional funds may be provided to equip the laboratories. For core subjects, laboratory work is deemed absolutely essential.

3. There is an urgent need to commence a Faculty Development Program to assimilate modern technologies and for the enhancement of instructional methodologies. The teaching faculty may be encouraged / facilitated to attend short courses, seminars and workshops in-country and abroad.

4. Trained and qualified manpower may be inducted on emergency basis to overcome the faculty shortage.

5. Special incentives may be devised for good teachers and students for their encouragement.

6. Engineering universities/colleges may be connected through LAN & WAN so that teachers and students may use Internet facility for R&D widely. This connectivity would result in useful interaction between the students, researchers and the faculty.

7. Use and application of simulation software tools may be introduced to students for the research/development work at appropriate levels.

8. For Mini as well as Final Year Projects, laboratories should be well equipped with components, devices and equipment of common use.

9. Final year projects must involve analysis, design and practical work / application. The examination for the project should include an open-house formal presentation by the students. Efforts may also be made to invite representatives from the local industry.

10. The Committee is fully cognizant of the need for very strong interaction amongst the universities on academic matters. Therefore, all universities are requested to disseminate any changes in their curricula to others as well.

11. All engineering institutions should encourage internship training, spanning 4 to 8 weeks for their students in the local industry. The Committee strongly opines that in order to ensure participation of our industry, a legal framework needs to be evolved at the Provincial and Federal Government levels.

12. Subject to availability of teaching faculty, engineering institution may also offer humanities courses in Philosophy, Psychology, Organizational Behaviour, Logic and Human Resource Development.

13. Teaching faculty may be provided opportunity to attend short courses, seminars and workshops in-country and abroad, related to their field of specialization.

14. Universities may like to launch PhD program in Avionics Engineering, under the guidelines set forth by HEC.

Annex - A

LIST OF OPTIONAL NON-ENGINEERING COURSES

Psychology and Human Behaviour

Course Contents:

- 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 Contents

- 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 Contents

- Introduction to Organizational Behaviour
  - Organizational Disciplines and topics
  - Psychological Perspective
  - Social-Psychological Perspectives
- Structure and Control in Organization
  - Introduction
  - Bureaucracy
  - Managerial Work
  - Contingency theory
  - Organizational Design
- Individual and Work Learning
  - Learning Theories
  - Learning and Work
- Stress
  - Types of Stress and Work
  - Occupational Stress Management
- Individual Differences
  - Personality and its factors
  - Personality dimensions and social learning
  - Intelligence
- Motivation and Job Satisfaction
  - Needs at Work
  - Theories of Motivation and job satisfaction
  - Correlates of Job satisfaction
  - Correlates of Job satisfaction
- Group and Work
  - Social Interaction
  - Dramaturgy and impression Management
  - Social Skill
- Group and Inter group Behaviour
  - Group Structure & Norms
  - Group Processes
  - How throne Studies
- Leadership
  - Leadership as an attribute
  - Leadership Style
- Patterns of Work
  - Work-the classical approach
  - Marx, Weber, & The critique of labor
  - Foucault & Disciplinary Power

- Conflict and Consent in Work
  - The labor Process debate
  - Work place control and resistance
  - Industrial conflict and industrial relations

- Organizational culture
  - Organizational culture and strategic management
  - Exploring organizational culture
  - Evaluating concept of 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.

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

Text Books:

- Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship
- P.N. Singh: Entrepreneurship fo0r Economic Growth
- Peter F. Drucker: Innovation and Entrepreneurship Peter F. Drucker
- 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

Text Books:

- Stephen P. Robins, Mary Coulter: Management
- H. Koontz Odonnel and H. Weihrich: Management
- Mc Farland: Management: Foundation and Practice
- Robert M. Fulmer: The New Management