CURRICULUM

OF

MECHATRONICS ENGINEERING
BS/BSc/BE

(Revised 2016)

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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Mr. Abid Wahab	Assistant Director (Curr)
Mr. Riaz-ul-Haque	Assistant Director (Curr)

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PREFACE

The curriculum, with varying definitions, is a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives and learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Knowledge in all academic disciplines is expanding and even new disciplines are also emerging, it is imperative that curriculum are developed and revised regularly.

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

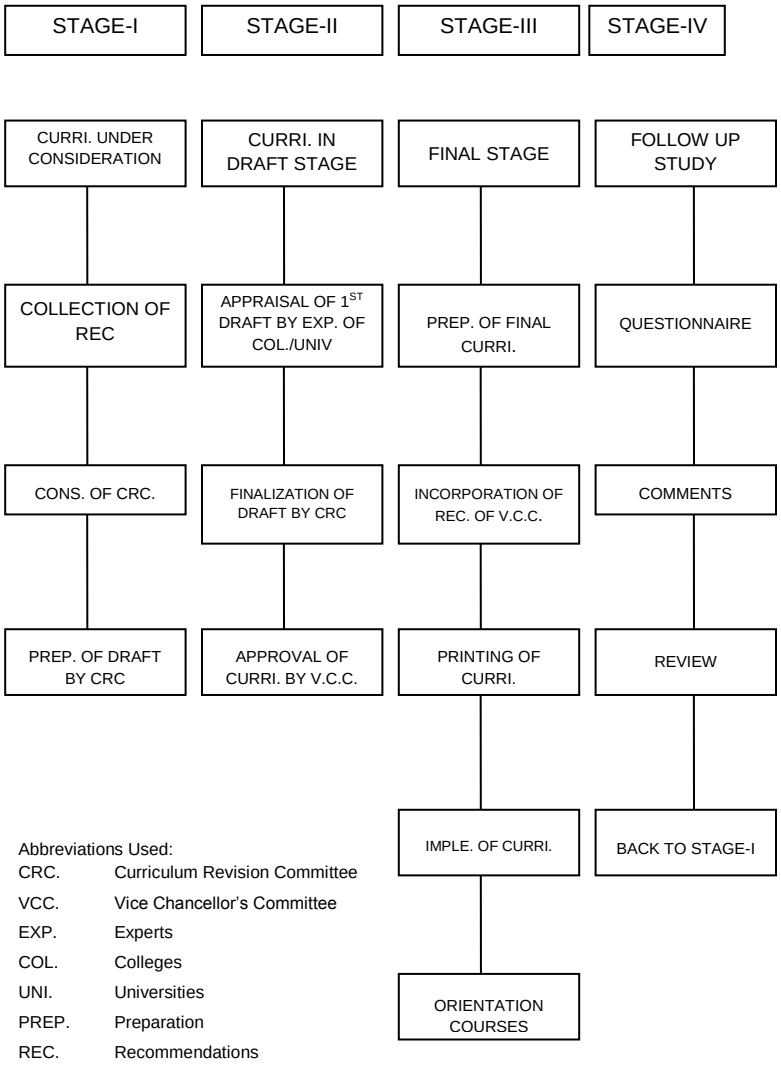
In compliance with the provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities,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

In order to impart education at par with quality international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 and 2009.

It is hoped that this curriculum document, prepared by the respective NCRC's, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC (www.hec.gov.pk).

(Fida Hussain)
Director General (Academics)

CURRICULUM DEVELOPMENT PROCESS



Abbreviations Used:

CRC.	Curriculum Revision Committee
VCC.	Vice Chancellor's Committee
EXP.	Experts
COL.	Colleges
UNI.	Universities
PREP.	Preparation
REC.	Recommendations

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NCRC.	National Curriculum Revision Committee
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INTRODUCTION

The Preliminary meeting of National Curriculum Revision Committee (NCRC) in the discipline of Mechatronics Engineering was held from October 19-21, 2015 at LEJ Centre, University of Karachi, under aegis of Higher Education Commission. The objective of meeting was to revise and prepare preliminary draft curriculum for BS/BE/BSc & MS/ME/MSc levels of Mechatronics Engineering. The following members attended the meeting:-

Sr.	Name & Address	Status
1.	Dr. Akhtar Nawaz Malik, Director, Foundation University, Rawalpindi Campus.	**Member/Convener**
2.	Dr. Kunwar Faraz Ahmad Khan, HoD, Department of Mechatronics Engineering, NUST College of E & ME, Peshawar Road, Rawalpindi.	**Member/Secretary**
3.	Dr. Zareena Kausar, HoD, Department of Mechatronic Engineering, Air University B-Block Ground Floor Sector E-9, Islamabad.	**Member**
4.	Mr. Syed Riaz Akbar Shah, Professor, Department of Mechatronic Engineering, University of Engineering & Technology, B-5 Phase V, Hayatabad, University Campus, Peshawar.	**Member**
5.	Dr. Jawaid Daudpoto, Professor, Department of Mechanical Engineering, Mehran University of Engineering & Technology, Jamshoro.	**Member**
6.	DR. Faraz Junejo, HoD, Department of Mechatronics, Shaheed Zulfiqar Ali Bhutto Institute of Science & Technology, 90 & 100 Clifton, Karachi.	**Member**

7.	Dr. Ahmad Hussain, Chairman / Professor, Department of Mechanical Engineering, Nazeer Hussain University, ST-2, Block # 4, Federal B Area, Karachi.	**Member**
8.	Dr. Nasimullah, Associate Professor, Electrical Engineering. City University of Science & Information Technology, Dalazak Road, Peshawar.	**Member**
9.	Dr. Sarvat Mushtaq Ahmad, Associate Professor /Dean, Faculty of Mechanical Engineering, GIK Institute of Engineering Science & Technology, Room # G03, FME, GIKI, Topi, Distt, Swabi. KPK.	**Member**
10.	Mr. Hashim Raza Senior Director, Nuclear Equipment Workshop-2, Pakistan Atomic Energy Commission, Plot # 3 & 4, Sector 22, Korangi Industrial Area, Karachi.	**Member**
11.	Dr. Abdur Rehman Abbassi, Head (MS Program), KINPOE (Affiliated with PIEAS) Karachi.	**Member**
12.	Dr. Aamir Hassan, Group Captain / Director, Design Management Office, Pakistan Aeronautical Complex, PAC Board, Kamran Kalan, District Attock.	**Member**
13.	Dr. Muzaffar Mehmood, Associate Professor, PAF-Karachi Institute of Economics & Technology, Main Campus, Korangi Creek, Karachi 75190.	**Member**
14.	Dr. Amir Sultan, Chairman, Department of Mechatronics Engineering, Chakwal campus, University of Engineering and Technology, Taxila.	**Member**

15.	Dr. Ali Raza, Assistant Professor, Department of Mechatronics & Control Engineering, University of Engineering & Technology, Lahore.	**Member**
16.	Dr. Bilal Ahmed Siddiqui, Assistant Professor, Department of Mechanical Engineering, DHA Suffa University, DG-78, Off Khayaban-e-Tufail, Phase VII (EXT), DHA, Karachi.	**Member**
17.	Dr. Syed Naqvi, Dean , Faculty of Computer Science, Institute of Business and Technology, Main Ibrahim Hydri Road, Korangi creek, Karachi.	**Member**

The meeting started with recitation of Verses from the Holy Quran by Mr. Riaz-ul-Haque, Assistant Director (Curriculum), HEC. Mr. Riaz-ul-Haque welcomed the participants on the behalf of HEC and thanked them for their participation in this important exercise.

The house unanimously selected Dr. Akhtar Nawaz Malik, Director, Foundation University, Rawalpindi as **Convener** and Dr. Kunwar Faraz Ahmad Khan, HoD, Department of Mechatronics Engineering, NUST College of Electrical & Mechanical Engineering, Rawalpindi as **Secretary** of the meeting. Mr. Haque then requested the respectable Convener & Secretary to convene proceedings of all technical sessions of the meeting for three days. The Convener thanked the participants for his selection and started proceedings of the meeting in accordance with the agenda.

Day 1

The convener emphasized the need for periodic revision of curriculum in view of the fact that new techniques and methodologies are evolving the world over at a fast pace. Since the initial Curriculum for BSc/BS/BE/MS Mechatronics was developed in 2011, the goal of this meeting was to finalize that draft curriculum with consensus. The meeting started with identifying the weakness observed by industrial reps in mechatronics graduates when they step into practical life and the means addressing this weakness through an improved design of curriculum. Another point of emphasis was the integration and interlinking of courses in the mechanical, electrical, computing domain to form a cohesive curriculum and plan of study, instead of simply grouping together a few courses from each domain. In order to realize this concept, four groups were formed to look into the four major domains of subjects, i.e., Mechanical, Electronics,

Mechatronics and Basic Sciences/Humanities. The groups were asked to analyze and revise the contents of courses in their domain with special emphasis to identify duplication in content with different subjects, propose integration measures and present their conclusions on the next day. Subsequently, all courses in the curriculum were discussed individually and an initial draft of the revised curriculum was formulated.

Day 2

On the day 2, the changes in the curriculum proposed in Day 1 were analyzed in detail and an exhaustive debate was carried out with input from the 4 groups regarding the courses within their domains. This resulted in the collective finalization of the course contents, allocation of credit hours, selection of text books, and elective courses. The elective courses were also discussed and it was proposed that in order to enable the formulations of streams at the undergraduate level the number of elective courses should be increased, which should be offered in the 3rd and 4th year. New courses were also proposed to be included as part of the core curriculum. The committee also focused on improving the social sciences domain of the curriculum and proposed an additional social science elective in the curriculum. At the end of the day, the BSc/BS/BE Mechatronics Curriculum was prepared and finalized for review of all members.

Day 3

On the final day of the meeting the Final Draft of the curriculum for the Mechatronics Engineering was compiled and finalized gathering all the recommendations. The course content was also thoroughly discussed with a view to eliminate duplication with the course. After three days of rigorous deliberations, the committee unanimously proposed the outlines of draft curriculum of Mechatronics Engineering for undergraduate & graduate engineers, which will be considered in the final meeting of NCRC scheduled within three months' time.

The Committee, during the proceedings of the meeting, agreed that the draft curriculum will be sent to all members of the Committee, and if possible to expatriate Pakistani Mechatronics Engineers living abroad for further critical analysis and to submit their critical evaluation, suggestions, and recommendations, within **one month** to the Convener/ Secretary for onward submission to HEC.

Ms. Ghayur Fatima, Director Curriculum, HEC who joined the session latterly thanked the Convener and all the members of the committee for their high quality contribution towards preparation of the preliminary draft curriculum in the discipline of Mechatronics Engineering. The committee appreciated the efforts made by Mr. Riaz-ul-Haque & Ms. Ghayur Fatima for their coordination and guidance during the whole sessions and lauded the local hospitality provided by LEJ center.

The committee also proposed a couple of initiative to strengthen Mechatronics Engineering activity in Pakistan. This includes formation of Society of Mechatronics Engineers of Pakistan (SMEP) and a call for 1st Mechatronics Systems Engineering Conference (MSEC) Pakistan in summer 2017. In addition in was recommended that a few subjects for example Environment, Health and Safety should be covered through seminars/workshop instead of including them as part of the curriculum. All universities are requested to take steps for holding such seminars.
The meeting ended with vote of thanks to and from the chair.

The final meeting of National Curriculum Revision Committee (NCRC) in the discipline of Mechatronics Engineering was held from March 7-9, 2016 at LEJ Centre, University of Karachi, to finalize the Curriculum for BSc/BS/BE Mechatronics Engineering. The following members attended the meeting:-

Sr.	Name & Address	Status
1.	Dr. Akhtar Nawaz Malik, Director, Foundation University, Rawalpindi Campus.	**Member/Convener**
2.	Brig. Dr. Javaid Iqbal, Dean, Department of Mechatronics Engineering, NUST College of E & ME, Peshawar Road, Rawalpindi.	**Member/Secretary**
3.	Dr. Zareena Kausar, HoD, Department of Mechatronic Engineering, Air University B-Block Ground Floor Sector E-9, Islamabad.	**Member**
4.	Dr. Jawaid Daudpoto, Professor, Department of Mechanical Engineering, Mehran University of Engineering & Technology, Jamshoro.	**Member**
5.	DR. Faraz Junejo, HoD, Department of Mechatronics, Shaheed Zulfiqar Ali Bhutto Institute of Science & Technology, 90 & 100 Clifton, Karachi.	**Member**
6.	Dr. Ahmad Hussain, Chairman / Professor, Department of Mechanical Engineering,	**Member**

	Nazeer Hussain University, ST-2, Block # 4, Federal B Area, Karachi.	
7.	Engg. Dr. Nasimullah, Associate Professor, Electrical Engineering. City University of Science & Information Technology, Dalazak Road, Peshawar.	**Member**
8.	Dr. Sarvat Mushtaq Ahmad, Associate Professor /Dean, Faculty of Mechanical Engineering, GIK Institute of Engineering Science & Technology, Room # G03, FME, GIKI, Topi, Distt, Swabi. KPK.	**Member**
9.	Mr. Abid Chohan Director Production, Nuclear Equipment Workshop-2, Pakistan Atomic Energy Commission, Plot # 3 & 4, Sector 22, Korangi Industrial Area, Karachi.	**Member**
10.	Dr. Abdul Rehman Abbasi Head (MS Program), KINPOE (Affiliated with PIEAS) Karachi	**Member**
11.	Dr. Muzaffar Mehmood, Dean, PAF-Karachi Institute of Economics & Technology, Main Campus, Korangi Creek, Karachi 75190.	**Member**
12.	Dr. Adeel Mehmood, Assistant Professor, Department of Electrical Engineering, COMSATS Institute of Information Technology Islamabad.	**Member**
13.	Mr. Bilal Ahmed Siddiqui, Assistant Professor, Department of Mechanical Engineering, DHA Suffa University, DG-78, Off Khayaban-e-Tufail, Phase VII (EXT), DHA, Karachi.	**Member**

14.	Dr. Amir Sultan, Chairman, Department of Mechatronics Engineering, Chakwal campus, University of Engineering and Technology, Taxila.	**Member**
15.	Dr. Syed Naqvi, Dean , Faculty of Computer Science, Institute of Business and Technology, Main Ibrahim Hydri Road, Korangi creek, Karachi .	**Member**
16.	Ms. Ghayyur Fatima, Director Academics Division, Higher Education Commission, Is lamabad	

Day 1

The meeting started with recitation of Verses from the Holy Quran by Dr. Sarvat Mushtaq Ahmad. Ms. Ghayyur Fatima, Director Academics Division, HEC welcomed the participants on the behalf of HEC and thanked them for their participation in this important exercise.

In the absence of Dr. Akhtar Nawaz Malik (Convener) due to flight delay, the house unanimously selected Brig. Dr. Javaid Iqbal, Dean, Department of Mechatronics Engineering, NUST College of E & ME, Peshawar Road, Rawalpindi as **Acting Convener** and Dr. Sarvat Mushtaq Ahmad,Dean, Faculty of Mechanical Engineering, GIK Institute of Engineering Science & Technology, Topi, Distt, Swabi as **Acting Secretary** of the meeting. Ms. Ghayyur Fatima then requested the respectable Convener & Secretary to convene proceedings of technical sessions. The Acting Convener thanked the participants for his selection and started proceedings of the meeting in accordance with the agenda.

Since the initial draft of the Curriculum for BSc/BS/BE Mechatronics was developed in an earlier meeting held between 19 -21 October 2015, the goal of this meeting was to finalize that draft curriculum with consensus. In this meeting, two groups were formed to look into the two major streams of Mechatronics, i.e., Mechanical and Electronics. The course contents developed by these groups were jointly discussed and unanimously approved. Furthermore, following additions were made to existing curricula for improvements.

- For clarity and uniformity FYP- HEC Course outline is written while taking into account Capston and NUST-FYP guidelines.

- Health and Safety education to be made mandatory through 1-2 days seminar/workshop for faculty, staff and students, preferably prior to commencement of BE studies.
- For complete coverage of PLOs, a Community Service Course (1-1) to be made mandatory. This course will consist of Seminars and field work. Field work can be carried out, such as working in Orphan House, old homes, Govt. School etc. This course will not contribute towards CGPA; however result (Satisfactory) will appear on transcript.

Day 2

Dr. Akhtar Nawaz Malik (Convener) chaired the meeting on second day; an exhaustive debate was carried out collectively resulting in the finalization of the course contents, allocation of credit hours, selection of text books, and elective courses. At the end of the day, the final draft of the BSc/BS/BE Mechatronics Curriculum was prepared approved.

Day 3

On third day; objective of the meeting was to finalize MS/MEng Mechatronics curricula. In this regard, a lengthy discussion was carried out, which resulted in the finalization of: different specializations, group of core and elective courses and selection of text books for MS/Meng Mechatronics Program. Furthermore, in continuation from last meeting, it was proposed to establish “Mechatronics Engineering Society Pakistan (MESP)” for promoting Mechatronics discipline in Pakistan. This society will aim to organize annual international conferences through collaboration of different Engineering Universities in Pakistan.

Ms. Ghayyur Fatima, Director Academics Division, HEC appreciated the Convener, Secretary and the members of the Committee for sparing their time for this noble cause.

The Meeting ended with the vote of thanks to the HEC, Convener, Secretary and members of National Curriculum Revision Committee.

Part I
4-YEARS BS/BSc/BE PROGRAMME

CURRICULUM FOR MECHATRONICS ENGINEERING

Mechatronics programme Educational Objectives

The programme educational objectives (PEOs) of Bachelor of Mechatronics Engineering are as under:-

The graduates of the programme should:

- Be employable mechatronic engineers who are knowledgeable, skilful and able to solve complex engineering problems.
- Have inclination towards research and lifelong learning and be able to promote entrepreneurial ideas.
- Be effective engineers with leadership qualities and high morals & professional ethics.

Mechatronics programme - outcomes

Mechatronics Engineering graduates must have achieved the following program learning outcomes at the time of graduation:

- **Engineering Knowledge**
  An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

- **Problem Analysis**
  An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

- **Design/Development of Solutions**
  An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

- **Investigation**
  An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

- **Modern Tool Usage**
  An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including

prediction and modeling, to complex engineering activities, with an understanding of the limitations.

- **The Engineer and Society**
  An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

- **Environment and Sustainability**
  An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

- **Ethics**
  Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

- **Individual and Teamwork**
  An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.

- **Communication**
  An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

- **Project Management**
  An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

- **Lifelong Learning**
  An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

BS/BSc/BE MECHATRONICS ENGINEERING PROGRAMME

Duration: 4 years
Number of semesters: 8
Number of weeks per semester: 18 (16 for teaching and 2 for examinations)
Total number of credit hours: 130-140
Number of credit hours per semester: 15-20
Engineering Courses (Minimum): 65-70 %
Non-Engineering Courses (Maximum): 30-35 %

Non-Engineering Domain									
Knowledge Area	Sub Area	Name of Course	Lec CH	Lab CH	Total CH	Total Courses	Total Credits	% Area	% Overall
Humanities	English	Communication Skill	2	0	2	6	12	30.77	8.76
		Technical Report Writing	2	0	2				
	Culture	Islamic Studies	2	0	2				
		Pakistan Studies	2	0	2				
	Social Sci	Social Science Elective I	2	0	2				
		Social Science Elective II	2	0	2				
Management Sciences		Engineering Economics	3	0	3	2	6	15.38	4.38
		Management	3	0	3				

		Sciences Elective							
Basic Sciences	Math	Calculus and Analytical Geometry	3	0	3	6	17	43.58	12.41
		ODE and Linear Algebra	3	0	3				
		Vector Calculus	3	0	3				
		Probability and Statistics	3	0	3				
		Complex Variables and Transforms	3	0	3				
		Numerical Methods	2	0	2				
	Physics	Applied Physics	3	1	4	1	4	10.25	2.91
Total			**38**	**1**	**39**	**15**	**39**	**100.00**	**28.48**
Community Service Learning (Non Credited Course)			1	1	2	-	-	-	-
Health and Safety Education			1-2 Days Seminar/Workshop for Faculty, Staff and Students						

Lec CH: Lecture Credit Hours, Lab CH: Laboratory Credit Hours

Engineering Domain									
Knowledge Area	Sub Area	Name of Course	Lec CH	Lab CH	Total CH	Total Courses	Total Credits	% Area	% Overall
Computing	Fundamentals	Computer Programming	2	1	3	3	10	10.20	7.30
	Programming	Data Structures and OOP	3	1	4				
	Design	Digital Logic Design	2	1	3				
Engineering Foundation		Workshop Practice	0	2	2	11	32	32.65	23.35
		Engineering Drawing	0	2	2				
		Engineering Statics	3	0	3				
		Engineering Dynamics	3	0	3				
		Mechanics of Materials	2	1	3				
		Materials and Manufacturing Processes	3	0	3				
		Theory of Machines	2	1	3				
		Fluid Mechanics	2	1	3				
		Electronic Devices and Circuits	3	1	4				
		Signals and Systems	2	0	2				

		Actuating Systems	3	1	4				
Major Based Core (Breadth)		Fundamentals of Thermal Sciences	3	1	4	8	28	28.58	20.43
		Modelling and Simulation	3	0	3				
		Electric Circuit Analysis	3	1	4				
		Electronic Circuits Design	3	1	4				
		Solid Modelling	0	1	1				
		Microcontroller and Embedded Systems	2	2	4				
		Instrumentation and Measurements	3	1	4				
		Control System	3	1	4				
Major Based Core (Depth)		Design of Machine Elements	2	0	2	8	22	22.45	16.06
		Manufacturing Automation	2	1	3				
		Mechatronic System Design	2	2	4				
		Robotics	3	1	4				
		Engineering Elective I	3	0	3				

		Engineering Elective II	3	0	3				
		Engineering Elective III	3	0	3				
Design Project		Senior Design Project	0	3	3	2	6	6.12	4.38
		Senior Design Project	0	3	3				
Industrial Training (Summer)			0	0	0	0	0	0.00	0.00
Total			**68**	**30**	**98**	**34**	**98**	**100.00**	**71.52**

ELECTIVES

Social Sciences Elective

1. Professional Ethics
2. Sociology and Development
3. Organizational Behavior
4. Introduction to Philosophy
5. English
6. Or any other relevant course (s)

Management Sciences Elective

1. Engineering Management
2. Total Quality Management (TQM)
3. Entrepreneurship, Leadership and Team Management
4. Principles of Management
5. Research Methodology
6. Knowledge Management
7. Or any other relevant course (s)

Engineering Electives

1. Power Electronics
2. Mechanical Vibrations
3. Special Topics in Mechatronics
4. Digital Signal Processing

5. Digital Control Systems
6. Digital Image Processing
7. Power Plant Systems
8. Introduction to Systems Engineering
9. Machine Vision
10. Artificial Intelligence
11. Precision Manufacturing
12. Energy resources and management
13. Intelligent Systems
14. Computer Aided Engineering
15. Digital Filter Design
16. Advanced Control Systems
17. Mobile Robotics
18. Internal Combustion Engine
19. Automotive Technology
20. Elect Instrumentation
21. Laser and its Applications
22. Condition Monitoring
23. Bio-Mechatronics
24. Data Communications and Networking
25. Fuzzy Logic
26. Applied Robotics
27. Internal Combustion Engines
28. Mechatronics Modeling for Automotive Systems
29. Power Train Systems
30. Embedded Systems
31. Computer Integrated Manufacturing
32. Or any other relevant course (s)

BS/BSc/BE MECHATRONICS ENGINEERING PROGRAMME
Summary

Domain	Knowledge Area	Total Courses	Total Credits	% Overall
Non-Engineering	Humanities	6	12	28.48
	Management Sciences	2	6	
	Basic Sciences	7	21	
	Sub Total	15	39	
Engineering	Computing	3	10	71.52
	Engineering Foundation	11	32	
	Major Based Core (Breadth)	8	28	
	Major Based Core (Depth)	8	22	
	Senior Design Project	2	6	
	Industrial Training (Summer)	0	0	
	Sub Total	32	98	
	Total	**47**	**137**	**100**

SCHEME OF STUDIES FOR
BS/BSc/BE IN MECHATRONICS

(The following scheme of studies is a guideline and different universities can tailor the scheme as per their requirements and limitations)

	Semester 1	
GS-1xx	Calculus and Analytical Geometry	3+0
ME-1xx	Engineering Statics	3+0
HS-1xx	Communication Skills	2+0
ME-1xx	Workshop Practice	0+2
EE-1xx	Electric Circuits Analysis	3+1
HS-1xx	Islamic Studies	2+0
	Total	13+3
	Semester Total	**16**
	Cumulative credits	**16**
1-2 Days Seminar/Workshop on Health and Safety Education		

	Semester 2	
GS-1xx	ODE & Linear Algebra	3+0
ME-1xx	Engineering Drawing	0+2
CS-1xx	Computer Programming	2+1
GS-1xx	Applied Physics	3+1
HS-1xx	Technical Report Writing	2+0
HS-1xx	Pakistan Studies	2+0
HS-1xx	Social Sciences Electives I	2+0
	Total	14+4
	Semester Total	**18**
	Cumulative Total	**34**

	Semester 3	
GS-2xx	Vector Calculus	3+0
EE-2xx	Electronics Devices and Circuits	3+1
ME-2xx	Engineering Dynamics	3+0
MTE-2xx	Solid Modelling	0+1
ME-2xx	Materials and Manufacturing Processes	3+0
CS-2xx	Data Structures and Object Oriented Programming	3+1
HS-2xx	Social Sciences Electives II	2+0
	Total	17+3
	Semester Total	**20**
	Cumulative Total	**54**

	Semester 4	
GS-2xx	Complex Variables and Transform	3+0
EE-2xx	Electronic Circuits Design	3+1
EE-2xx	Signals and Systems	2+0
ME-2xx	Mechanics of Materials	2+1
CS-2xx	Digital Logic Design	2+1
MTE-2xx	Actuating Systems	3+1
	Total	15+4
	Semester Total	**19**
	Cumulative credits	**73**

	Semester 5	
GS-3xx	Probability and Statistics	3+0
MTE-3xx	Microcontroller and Embedded Systems	2+2
ME-3xx	Fluid Mechanics	2+1
MTE-3xx	Instrumentation and Measurement	3+1
ME-3xx	Theory of Machines	2+1
HS-3xx	Management Sciences Elective	3+0
	Total	15+5
	Semester Total	**20**
	Cumulative Credits	**93**

	Semester 6	
GS-3xx	Numerical methods	2+0
MTE-3xx	Mechatronics Systems Design	2+2
MTE-3xx	Design of Machine Elements	2+0
MTE-3xx	Engineering Elective I	3+0
MS-3xx	Modelling and Simulation	3+0
ME-3xx	Fundamentals of Thermal Sciences	3+1
	Total	15+3
	Semester Total	**18**
	Cumulative Credits	**111**

	Semester 7	
MTE-4xx	Robotics	3+1
MTE-4xx	Control Systems	3+1
MTE-4xx	Engineering Elective II	3+0
MS-4xx	Engineering Economics	3+0
MTE-4xx	Senior Design Project	0+3
	Total	12+5
	Semester Total	**17**
	Cumulative Credits	**128**
CSL-4xx	Community Service Learning	1+1

	Semester 8	
MTE-4xx	Engineering Elective III	3+0
MTE-4xx	Manufacturing Automation	2+1
MTE-4xx	Senior Design Project	0+3
	Total	5+4
	Semester Total	**9**
	Cumulative Credits	**137**

DETAIL OF COURSES
CONTENTS AND TEXT BOOKS
B.E. MECHATRONICS ENGINEERING

GS-1xx CALCULUS AND ANALYTICAL GEOMETRY

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

This course advances conceptual and technical competencies in analytical geometry and calculus. On successful completion of this course students should be able to effectively communicate the mathematical concepts, reasoning and technical skills contained in this course.

Topics Covered

Vectors, Scalars and Vector products, Definitions of limits & continuity, techniques of finding limits, Definitions of limits & continuity, techniques of finding limits, Techniques of differentiation, tangent lines and rates of change, Extreme functions, Rolle's and Mean value theorems, concavity and optimization problems, Techniques of indefinite integration, Definite integrals, properties of definite integrals, Solids of revolution, volume of solids of revolution, Arc length, surface of revolution, center of mass, Integration of transcendental functions, Indeterminate forms and L'Hopital's rule, Integrals of trigonometric and rational functions, improper integrals, Convergence and divergence of sequences and series, positive terms series, integral test, p-series, Basic comparison test, limit comparison test, the ratio and root tests, alternating series, absolute and conditional convergence, Power series, Maclaurin series, Taylor series and their applications.

Recommended Books

1. Calculus (Latest Edition) by Swokowski, Onlinick& Pence.
2. Calculus and Analytical Geometry (Latest Edition) by G.B. Thomas & R. L Finney.
3. Essentials of Mathematics by M. Rafique.

ME-1xx ENGINEERING STATICS

Theory Cr Hrs, 3
Lab Cr Hrs, 0

Course Objectives

The objective of this course is to develop the capacity to predict the effects of force system while carrying out the creative design function of engineering.

Topics Covered

Force System

Force and its rectangular and oblique axis components (two and three dimensional systems). Moment and resultant couple (two and three dimensional systems). Equilibrium Mechanical systems, free body diagram and equilibrium conditions for two and three dimensional systems, Structures, Plane trusses. Solution of plane trusses with method of joints and method of sections, Frames.

Distributed Forces

Centroids, composite centroids, Distributed force system.

Friction

Types of friction, Application of friction.

Recommended Books

1. Engineering Mechanics (Vol. 1) by R. C. Hibbler, Pearson, Latest Edition.
2. Engineering Mechanics (Vol. 1) by J. L. Meriam& L. G. Kraige, Wiley, Latest Edition.
3. Mechanics for Engineers, Statics, by F. P. Beer & E. R. Johnston, McGraw Hill, Latest Edition.
4. Engineering Mechanics: Statics & Dynamics (Vol. 1) by I. H. Shames, Prentice Hall, Latest Edition.

ME-1xx WORKSHOP PRACTICE

Theory Cr Hrs, 0 **Lab Cr Hrs, 2**

Course Objectives

The students are made familiar with engineering processes in various workshops. They get hands on experience so that they are well aware of the trends and techniques in various technologies employed in order to solve engineering problems.

Topics Covered

Introduction to sensors, different types of sensors and switches. Introduction to electronic devices, Introduction to hydraulic and electric actuators. Introduction to derives and mechanisms used in mechatronic systems, Basic theory and practice on the following shops: Fitting shop, Woodwork shop, Electrical shop, Forging shop, Foundry Shop, Elementary Machine shop (Lathe & Milling), Welding shop, PCB soldering, Introduction to computer hardware.

Recommended Books

1. Workshop Technology, Part I & II, by W. A. Chapman, Arnold Pub, Latest Edition.
2. Workshop Technology, Part III by W. A. Chapman, Arnold Pub, Latest Edition.
3. Any book of manufacturing processes.

EE 1xx ELECTRIC CIRCUITS ANALYSIS

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives

This is the electrical foundation course in Mechatronics Engineering. The course aim is to familiarize the students with passive electrical components and circuit analysis principles.

Topics Covered

Basic Circuit Elements, Ohm's law, KCL and KVL, Series and Parallel Circuits, Node and Mesh Analysis, Linearity and Superposition Principles, Network Laws like Thevenin and Norton Theorem, Maximum Power Transfer Theorem, Inductive and Capacitive circuits, concepts of circuit reactance and impedance, Natural response of 1st order circuits, 1st order circuits with dependent sources, Response of 1st order circuits to constant forcing function, Response of 1st order circuits to non-constant forcing function, Complete response of 2nd order circuits. Solving Circuit differential equations using Laplace Transform, Laplace transform of special signals, direct transformation of circuits in to s-domain, AC steady state power, Concepts of average power, complex power and power factor

Recommended Books

1. Fundamentals of Electric Circuits by Sergio Franco Oxford English Press, Latest Edition Engineering Circuit Analysis by Hayt, Kimmerly and Durbin, McGraw Hilll, Latest Edition.
2. Fundamentals of Electric Circuit, Latest Edition, by Charles k Alexander & Mathew, N.O Sadiku

HS-1xx Health and Safety Education
1-2 Days Seminar/Workshop

Course Objectives

The objective of this Seminar/Workshop is to train the faculty, staff and students of occupational health and safety measures and hazards while working in labs. The main focus is to take preventive actions and know

about the risks associated with working with lab equipment, chemicals, heavy machinery etc.

Topics Covered

Introduction to Occupational health and Safety (OH&S), Hazards identification, Risk assessment and Risk Control Strategies, Fire (types and Safety procedures and risk assessments), Electrical Hazards and its risk assessments, Chemical hazards and safety procedures of Chemical handling, Investigation procedures, PTW (Permit to Work), Work Equipment Hazards(Mechanical Tools and machines) and Risk Control, Physical and Psychological Health Hazards and Risk Controls, Understanding Responsibilities(Employer & Employee), Protecting our Environment.

Recommended Books

1. Safety and Health for Engineers, By Roger L. Brauer

GS-1xx ORDINARY DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

The course will cover concept of linear systems of ordinary differential equations and Laplace transform methods. At the end, the students should be able to apply the fundamentals and applications of Ordinary Differential equations and Linear Algebra concepts.

Topics Covered

Introduction to Differential Equations, ODE of First order and first degree, ODEs of second and higher orders. Non-homogeneous linear differential equations, Systems of linear differential equations. Introduction to matrices, Algebra of matrices, Special matrices, Determinants and their properties, Linear independence, bases, Vector space, System of linear equation, Gauss elimination, Eigenvalues, Eigenvectors.

Recommended Books

1. Advanced Engineering Mathematics (Latest Edition) by E. Kreyszig.
2. Ordinary Differential Equations and BVPs by M. Rafique, Latest Edition.
3. Modern Engineering Mathematics by Glyn James, Latest Edition.

ME-1xx ENGINEERING DRAWING

Theory Cr Hrs, 0 **Lab Cr Hrs, 2**

Course Objectives

The objective of this course is to learn the language of engineering and technical drawing. Students learn basic drafting using both manual and computer aided techniques. At the end of the course students will be able to read, draw and modify engineering drawings both in manual and digital formats in such details that is suitable to both designer and manufacturer.

Topics Covered
Engineering Drawing

Introduction to Engineering Drawing, Types of lines and usage, Basic geometrical Constructions, Theory of Orthographic projection; First angle and third angle projections. Dimensioning and lettering, Tolerances, Fits, Projections of points, straight lines, planes and solids. Sectioning of solids, Isometric projections, Development of surfaces, Drawing symbols.

CAD Package

Introduction to CAD tool, Understanding and drawing simple 2D objects, Coordinate systems, Modifying drawing objects. Drawing in layers, creating complex drawings, Sectioning, Hatching, Text, Blocks, Dimensioning, Isometric views, Fits and Tolerance, Symbols for welding, Surface finish, Threaded parts, electronics, Solids and surfaces, Extracting views from model space into paper space, Creating layouts in Paper space, Plotting a drawing, Plotting from model space.

Recommended Books

1. First year Engineering Drawing, by A. C. Parkinson, Latest Edition.
2. Engineering Drawing and Graphic Technology, by T. E. French, C. J. Vierck, R. J. Foster, McGraw Hill.
3. CAD Packages by T.F. French.
4. Any book relevant to the CAD tool used in the lab.

CS-1xx COMPUTER PROGRAMMING

Theory Cr Hrs, 2 **Lab Cr Hrs, 1**

Course Objectives

This course is intended to provide latest approaches in algorithm development and computer programming using a modern language like C/C++.

Topics Covered

Introduction to Computer Organization, Algorithms, Computer languages, Compiler, Assembler and Interpreter. A typical IDE (Microsoft Visual C++ 6.0), Data, Data types, Data representation, Identifiers, Reserved words, Variables and constants, Inputs and outputs, Standard Library (STL), Arithmetic and logical Operators, If and If/else statements and conditional expressions , Switch statements, Loops, Functions (including const functions and const arguments), Arrays, searching and sorting as exercises for arrays and loops, Pointers, Structures, Structure declaration, accessing structure members, array of structures, Passing structures as function arguments, File handling , dynamic memory allocation.

Recommended Books

1. C++ How to program by Deitel and Deitel, Prentice hall, Latest Edition, ISBN: 0-13-185757-6.
2. Programming with ANSI C by B. J. Holmes, Latest Edition.
3. C for yourself by Richard P. Halpern, Latest Edition.
4. Problem Solving with C++ by Walter Savitch, Latest Edition.

GS-1xx APPLIED PHYSICS

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives

The main objective of this course is to develop an understanding of physical processes which govern the nature. Special emphasis is given to certain key branches in physics like mechanics, electromagnetism, and material/energy properties in a given environment. The course is intended to laying the foundation of students before they encounter hardcore engineering subjects.

Topics Covered

Kinematics in Two Dimensions; Vectors, Motion and Force: Dynamics, Work and Energy, Bodies in Equilibrium, Friction, Mechanical properties of Materials, Forces due to Fluids, Pressure in fluids, Temperature and Kinetic Theory, Thermal expansion of solids, Liquids and Gases, Transmission of Heat, Optics: Lenses, Mirrors, Optical instruments, Fundamentals of electromagnetism, Introduction to Semiconductors.

Recommended Books

1. Principles of Physics by M. Nelkon, Collins Int. Textbook Dept., Latest Edition.
2. Physics, Principles with Applications by Douglas C. Giancoli,

Prentice Hall, Latest Edition
3. Physics by Tom &Duncon, Latest Edition
4. Physics by Halliday & Resnick, Latest Edition.
5. College Physics, by Frederick J. Bueche, Eugene Hecht, Schaum's Outlines Series.

HS-1xx TECHNICAL REPORT WRITING

Theory Cr Hrs, 2 **Lab Cr Hrs, 0**

Course Objectives

This course equip students with writing skills as may form useful foundation to respond with proficiency, to job-seeking situations, initial office correspondence/tasks or to pursue higher education/research at Postgraduate level.

Topics Covered

Technical Writing, Research Writing, Letter Writing, Personal Letters, Business Writing, Practice.

Recommended Books

1. Reports, Technical Writing and Specifications by Glidon H.K, McGraw-Hill Book Company, London, Latest Edition.
2. Technical Writing by Steve M. Gerson, Latest Edition.
3. Reporting Technical Information by Kenneth W. Houp, Thomas E. Pearsall, Tebeaux and Dragga, Latest Edition.
4. Technical Communication by Rebecca E. Burnett, Latest Edition.

GS-2xx VECTOR CALCULUS

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

This course focuses on understanding the concepts of vectors, functions of more than one variable, partial differentiation, and multiple integrals. Applications to geometry and physics, as well as other real- life problems are particularly emphasized in the course.

Topics Covered

Analytical Geometry in 3-space, Cylindrical and Spherical cords, Surfaces, Vector & Scalar functions and fields, Curves, Tangents, Arc length of a curve, Velocity, Acceleration, Curvature & Torsion of a curve, Gradient of a Scalar Field and directional derivatives, Divergence of a Vector Field, Curl of a Vector Field, Gradient, Divergence and Curl in Curvilinear

coordinates, Line integral, integration around closed curves, Application of double integrals,

Green's theorem, Tangent planes, Surface normal, Surface integrals, Triple integrals, Divergence theorem of Gauss, Application of the Divergence theorem, modeling of heat flow, Stokes's theorem.

Recommended Books

1. Advanced Engineering Mathematics (Latest Edition) by E. Kreyszig.
2. Vector and Tensor Analysis with Applications by Borisenko & Taranov, Latest Edition.

EE-2xx ELECTRONIC DEVICES AND CIRCUITS

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives

This course explains the basic concepts of semi-conductor and PN junction. Semiconductor devices including Diodes, Bipolar Junction Transistors (BJTs), Field Effect Transistors (FETs) and their application circuits are discussed in detail.

Topics Covered

Basic concepts of semiconductor and PN junction physics, Diodes, terminal characteristics of junction diodes, analysis of diode circuits, small signal model and its applications, Zener diodes, Rectifier circuits, Limiting & Clamping circuits.

Physical Structure and operating principles of BJTs, basic BJT circuit configurations, DC analysis, Small signal and large signal models of BJT, BJT as a switch.

Physical Structure and operating principles of FETs, MOSFETs, Enhancement and Depletion type MOSFETs, basic MOSFET circuit configurations, DC analysis, Small signal and large signal models of MOSFETs.

Recommended Books

1. Microelectronics Circuits, Latest Edition By A.S. Sedra & K. C. Smith Oxford University Press.
2. Microelectronics, Latest Edition, by Millman & Grabel, McGraw Hill.
3. Electronic Devices & Circuit Theory, Latest Ed., by R. Boylestad and L. Nashelsky.

ME-2xx ENGINEERING DYNAMICS

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

The objective of this course is to develop the capacity to predict the effects of force and motion while carrying out the creative design function of engineering.

Topics Covered

Kinematics of Particles

Rectilinear motion, Plane curvilinear motion, Rectangular coordinates, Normal and tangential coordinates, Polar coordinates, constrained motion.

Kinetics of Particles

Force, mass, and acceleration, Newton's second law of motion, equations of motion, Rectilinear and curvilinear motion, Work and energy principle, potential energy, Impulse and momentum, conservation of momentum.

Plane Kinematics of Rigid Bodies

Angular motion relations, concept of absolute and relative motion (velocity and acceleration), Instantaneous centre of zero velocity.

Plane Kinetics of Rigid Bodies

Force, mass, and acceleration, general equation of motion, Translation, fixed axis rotation, Work and energy relationship, Impulse and momentum equation.

Recommended Books

1. Engineering Mechanics dynamics by R. C. Hibbeler, Pearson, Latest Edition.
2. Engineering Mechanics (Vol. II) by J. L. Meriam& L. G. Kraige, Wiley, Latest Edition.
3. Mechanics for Engineers, Dynamics, by F. P. Beer & E. R. Johnston, McGraw Hill, Latest Edition.
4. Engineering Mechanics: Statics & Dynamics by I. H. Shames, Prentice Hall, Latest Edition.

MTE-2xx SOLID MODELING

Theory Cr Hrs, 0 **Lab Cr Hrs, 1**

Course Objectives

The main objectives are to provide students with a conceptual understanding of the principles of CAD systems, the implementation of

these principles, and its connections to CAM and CAE systems. The generic aspect of CAD software systems will be discussed. A large portion of the students' time will be spent independently in the computer labs learning the details of design and analysis related to the product realization process. The software system used in teaching/learning is Pro/ENGINEER Wildfire.

Topics Covered

Getting Acquainted with the Pro/E Interface, Pro/Engineer Wildfire 4 User Interface, Sketcher, Datum features, Extruded Protrusions & cuts, Holes, Rounds and Chamfers, Shells, Ribs, Feature Modification and Manipulation, Patterns and Copies, Revolved Protrusions & cuts, Sweeps and Swept Protrusions & cuts, Blended Protrusion & Swept blends, Assembly Modeling, Sheet Metal Design, Surface Modeling, Style features, Motion, Structure and Thermal Analyses

Recommended Books

1. PTC Design & Technology in Schools Curriculum
2. Getting Started with Pro/ENGINEER Wildfire by Robert Rizza

ME-2xx MATERIALS AND MANUFACTURING PROCESSES

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

This course is designed to introduce the students to the structures and properties of materials. This course also provides the students an insight into different manufacturing processes used in the industry.

Topics Covered

Engineering Materials

Engineering Properties of Materials, Concept of Structures, Metals andAlloys,Ceramics, Polymers, Composites, Semiconductors, MaterialsCharacterization, Scanning Probe Microscopy, Non-Destructive Testing, andMaterial Selection.

Manufacturing Processes

Manufacturing Systems, Modern Casting, Conventional machining; turning, milling, tool geometry, chips formation, material removal rate. Non-conventional machining; EDM, ECM, water jet machining, laser, EBW etc. Welding Processes, Heat Treatment, Electronic Fabrication, Rapid Prototyping.

Recommended Books

1. Elements of Material Science and Engineering by L. H. Van Vlack, Addison Wesley Publishing Co., Latest Edition.
2. Engineering with Polymers by P. C. Powell, Chapman and Hall, Latest Edition.
3. Manufacturing Processes by Amstead, Begeeman and Ostwald, John Wiley & Sons, Latest Edition.
4. Materials and Processes in Manufacturing by E. Paul DeGarmo, Wiley, Latest Edition.

CS-2xx DATA STRUCTURES AND OBJECT ORIENTED PROGRAMMING

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives

To teach students different data structures that are required to design and implement various software projects. The course also aims to teach the implementation of data structures using object-oriented language C++. It will familiarize the students with practical applications of data structures. The students will also be taught basic techniques for analysis of algorithms.

Topics Covered

Introduction to Object Oriented Programming, Introduction to Data Structures, Abstraction and ADTs, Built-in Data Structures in C++, Linked Lists, Stacks and Queues, Recursion, Trees, Graphs, Runtime Analysis, Sorting and Searching, Classes, Objects, Access Specifiers, Data Members, Member Functions, Abstract Data Types (ADT), Information Hiding, Encapsulation and Reference Variables, Constructors and Destructors(Overloaded Constructors, Default Constructors, Copy Constructor, Conversion Constructor), Shallow vs Deep Copy, Properties, Getters and Setters, Static Data Members and Static Member Functions, Function Overloading, Operator Overloading and Templates, Inheritance, Types of Inheritance, Derived Classes and Method Overriding, Representing classes using UML Diagrams.

Recommended Books

1. Mark Allen Weiss, “Data Structures and Problem Solving Using C++”,
   3rd Ed, Addison Wesley, 2009.
2. Dietel and Deitel, “C++ How to Program”, Latest Edition.
3. Michael T. Goodrich, Roberto Tamassia, David Mount, “Data Structures and Algorithms in C++”, Wiley, 2004.
4. Frank M. Carrano, “Data Abstraction and Problem solving with

C++", Latest Edition.
5. Adam Drozdek, "Data Structures and Algorithms in C++", 3rd Ed., Thomson, 2005.
6. Robert Lafore, "Object Oriented Programming with C++", Sams, 2002.
7. Booch and Rumbaugh, "The Unified Model Language User Guide", 2nd Ed, Addison Wesley, 2005

GS-2xx COMPLEX VARIABLES AND TRANSFORMS

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

This course covers complex variable analysis and Fourier analysis. After successfully completion of the course, the students should be able to calculate and manipulate several important transforms and to apply these transforms to linear systems, wave propagation, and signal analysis.

Topics Covered

Complex numbers: Basic concepts, Polar Form, Euler Formula, Limit, continuity and Differentiability of Complex functions, Fourier series for functions of any period, Even and Odd functions, Half range expansions, Complex Fourier series, Fourier integral, Fourier Cosine and Sine Transforms, Fourier Transform of the Derivatives, Convolution, Partial differential equations solvable as ODEs, Modeling a Vibrating String, Derivation of Wave Equation, Solution by the Method of Separation of Variables, using Fourier Series, D'Alembert's Solution of the Wave Equation, Heat Equation; its Solution by Fourier Series and Fourier Integrals, Rectangular and circular membrane, Use of Double Fourier Series, Laplace's Equation, Laplacian in Spherical Coordinates, Solution of PDEs by Laplace and Fourier transforms.

Recommended Books

1. Advanced Engineering Mathematics (Latest Edition) by E. Kreyszig.
2. Vector and Tensor Analysis with Applications by Borisenko&Taranov, Latest Edition.

EE-2xx ELECTRONIC CIRCUITS DESIGN

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives

This course covers the different aspects of transistor circuit Design and in-depth analysis of these circuits including frequency response, Operational Amplifiers and design of special electronic circuits.

Topics Covered

Circuit modelling in s-domain, pole and zeros, Bode plots, Frequency response of different single stage amplifier configurations of BJTs and MOSFETs, Miller's theorem, Differential and Multistage Amplifiers, Feedback configurations, Active Filters, Ideal linear op-amp circuits: inverting amplifier, non-inverting amplifier, summing amplifier, instrumentation amplifier, Non-ideal linear op-amp circuits, such as voltage follower, inverting amplifier, non-inverting amplifier, Static limitations of op-amps: bias current, offset current, offset voltage

Recommended Books

1. Microelectronics Circuits, Latest Edition By A.S. Sedra& K. C. Smith Oxford University Press.
2. Microelectronics, Latest Edition., by Millman&Grabel, McGraw Hill.
3. Electronic Devices & Circuit Theory, Latest Ed., by R. Boylestad and L. Nashelsky.

MTE-2xx SIGNALS AND SYSTEMS

Theory Cr Hrs, 2 **Lab Cr Hrs, 0**

Course Objectives

This course would develop a good understanding about Signals and Systems as they occur in various domains. Various Signal Transformations and associated mathematical representations would be elaborated. It would help develop expertise to model, analyze and process signals as it occurs in different domains.

Topics Covered

Continuous-time (CT) and discrete-time (DT) signals; signal energy and power, time shift, reversal, and scaling; periodic signals; even and odd signals, CT and DT Complex Exponential and Sinusoidal Signals, Periodicity Properties, unit impulse and unit step signals, Memory, Invertibility, Causality, Stability, Time Invariance, Linearity, DT and CT representation in terms of impulses, DT Unit Impulse Response, Convolution-Sum representation of LTI Systems, CT Unit Impulse Response, Convolution-Integral Representation of LTI Systems, Fourier Series Representation of Continuous and Discrete Time Periodic Signals, Properties of Continuous and Discrete Time Fourier Series, Continuous and Discrete time Fourier Transform, Sampling, Laplace and Z transforms, Region of convergence , BIBO stability, LTV systems

Recommended Books

1. Signals And Systems by Alan V. Oppenheim

2. Signals And Systems – Continuous and Discrete by Rodger E. Ziemer, William H. Tranter, D. Ronald Fannin
3. Signals And Systems – Analysis Using Transform Methods and MATLAB by M.J. Roberts
4. Digital Signal Processing – A Computer Based Approach Third Edition by Sanjit K. Mitra

ME-2xx MECHANICS OF MATERIALS

Theory Cr Hrs, 2 **Lab Cr Hrs, 1**

Course Objectives

This course is a foundation to many advanced techniques that allow engineers to design structures, predict failures and understand the physical properties of materials. Mechanics of Materials provides the students basic tools for stress, strain and strength analysis. Methods for determining the stresses, strains and deflections produced by applied loads are learned.

Topics Covered

Concepts of stress and strain, Axial loading, Torsion, Pure bending, Shear Force and Bending Moment Diagrams, Beams under transverse loading, Transformation of stress and strain, biaxial stress, Mohr's Circle, Deflection of beams, Beam design, Columns.

Recommended Books

1. Mechanics of Materials by E. P. Popov, Prentice Hall Inc., Latest Edition.
2. Mechanics of Materials by F. P. Beer and E. R. Johnson, Latest Edition.
3. Strength of Materials by J. Alexander, Latest Edition.
4. Mechanics of Engineering Materials by P. P. Crawford, Latest Edition.
5. Mechanics of Materials, by R. C. Hibbeler, Pearson, Latest Edition.
6. Mechanics of Materials by Anscl C. Ugural, Wiley, Latest Edition.
7. Strength of Materials, by A. Pytel and F. L. Singer, Harper and Row, Latest Edition.

CS-2xx DIGITAL LOGIC DESIGN

Theory Cr Hrs, 2 **Lab Cr Hrs, 1**

Course Objectives

This course introduces the foundation of Digital Computer Design.

Numbering systems and Boolean algebra become the basis of this course. At the end of the course, the students should be able to design different combinational and sequential circuits leading to the design of complex digital systems such as ALU.

Topics Covered

Numbering System, Boolean algebra, Logic Gates and truth tables, Karnaugh Maps, minimization techniques for digital circuits, Combinational Logic Design, Combinational Logic with MSI and LSI, Flip Flops and Latches, Sequential Logic Design, Registers and Counters, ALU Design, Finite State Machine (FSM), Memory and Programmable Logic Devices.

Recommended Books

1. Digital Logic and Computer Design by M. Morris Mano, Prentice Hall (India), Latest Edition.
2. Digital Fundamentals by Thomas L. Floyd, Latest Edition, Prentice Hall International.
3. Digital Logic & State Machine Design by David J. Comer Latest Edition, Saunders College publishing.
4. Logic Circuit Design by A.W. Shaw, Oxford University Press, Latest Edition.
5. Digital Computer electronics by Malvino and Brown, Career Education, Latest Edition.

MTE-2xx ACTUATING SYSTEMS

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives

The objective of this course is to get the students familiarize with the basic principles of actuating systems including: solenoids, dc motors and ac motors (synchronous and asynchronous). Furthermore, other actuating systems using hydraulics and pneumatics principles will also be explained.

Topics Covered

Concepts of actuating systems,

Solenoids, principles of electro-mechanical energy conversion and rotating machines, Applications of AC motors (including synchronous and asynchronous options), Operating principles of DC machines, Modeling of DC motor, Brush less DC motor,
Hydraulic and pneumatic actuating devices, hydraulic valve types, configuration and characteristic responses, Pneumatic valve types,

configuration and characteristic responses, Design and application of hydraulic and pneumatic systems, electro-hydraulic and electro-pneumatic systems, Principles of actuator selection and methods to evaluate their performance.

Recommended Books:

1. Electric Machinery Fundamentals by Stephen J Chapman, Latest Ed.
2. Electric Machinery Fritzgerald, CharlsKingesly and Umans, Latest Ed.
3. Pneumatics and Hydraulic Systems, by W. Bolton, Butterworth Heinemann Ltd., Latest Edition.

GS-3xx PROBABILITY AND STATISTICS

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

This course introduces the concepts of probability and statistics. The student would be able to apply this knowledge on a wide variety of engineering problems.

Topics Covered

Graphical Representation of Data: Stem-and-Leaf Plot, Histogram, Box plot; Mean, Standard Deviation, Variance ,Sample Space, Experiment Outcomes, Sampling with and without replacement, Set theory, Introduction to theory of Probability, Theorems of Probability, Conditional probability, Permutations and Combinations, Random Variables and Probability Distributions, Mean and Variance of a Distribution, Expectation, Moments.

Binomial, Poisson & Hyper geometric distributions, Normal distribution, Marginal distribution, Distributions of Several Random Variables, Random Sampling, Random numbers, Processing of Samples, Estimation of parameters, Confidence intervals, Testing of hypothesis, Quality control, Control chart, Acceptance sampling, errors & rectification, Goodness of Fit, Chi-square test. Curve fitting, Regression Analysis, Curve Fitting.

Recommended Books:

1. Probability and Statistics by Murray R. Spiegel (Latest Edition).
2. Advanced Engineering Mathematics (Latest Edition) by E. Kreyszig.

MTE-3xx MICROCONTROLLER AND EMBEDDED SYSTEMS

Theory Cr Hrs, 2 **Lab Cr Hrs, 2**

Course Objectives

This course covers the introduction of embedded systems with

microcontrollers and programmable logic devices. The architecture, programming, system development/simulation tools are introduced. Complete digital systems with different peripherals and data communication are designed, simulated and implemented.

Topics Covered

Introduction to Microprocessors and Microcontrollers, architecture of a modern microcontroller, Software/firmware development tools, Programming languages; Assembly and C, Simulation tools like Proteus, Digital systems design using internal resources, external peripherals and devices, Implementation of data communication; RS-232, I2C, SPI etc. Introduction to embedded systems, Hardware architecture for embedded systems: Microcontrollers, Programmable logic devices like, Programmable array logic (PAL) and its variants, and Field Programmable Gate Arrays (FPGA) and its variants, Programming of embedded systems with Microcontroller and FPGA, Introduction to Verilog.

Recommended Books

1. PIC Microcontroller and Embedded Systems using Assembly and C for PIC 18 by Muhammad Ali Mazidi, Prentice Hall, Latest edition
2. AVR Microcontroller and Embedded Systems using Assembly and C. by Muhammad Ali Mazidi, Prentice Hall, Latest edition
3. 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi, Prentice Hall, Latest edition
4. Computer Architecture, A Quantitative approach by Dr. David A. Patterson and Dr. Paul Hennessey, , Latest edition
5. Embedded System Design: A unified Hardware/Software Introduction. By Frank Vahid& Tony D. Givarigis, Latest edition
6. Embedded System Design. Hardware/ Software System, by P. Marwedel, Latest edition
7. FPGA prototyping by VHDL examples: Xilinx Spartan-3 version, By Pong P. Chu - Wiley-Interscience, Latest edition.
8. Introduction to Embedded Systems - A Cyber-Physical Systems Approach, E. A. Lee and S. A. Seshia, Latest edition
9. Introduction to Embedded Systems: Using ANSI C and the Arduino Development Environment. By David Russel, Latest edition

ME-3xx FLUID MECHANICS

Theory Cr Hrs, 2 **Lab Cr Hrs, 1**

Course Objectives

To introduce the preliminary concepts of fluid statics, fluid dynamics, hydraulics, and pneumatics. Particular focus is on application of hydraulics

and pneumatics in Mechatronics systems.

Topics Covered

Introduction to Fluid Mechanics
What is fluid, classification of fluid, and fluid properties

Fluid Statics
Basic equation for pressure field, pressure measuring devices, hydrostatic forces on submerged surface, buoyancy, floatation and stability

Fluid Dynamics
Principles of fluid motion, Definition of path line, streamline, streak line and timeline. Derivation of Bernoulli's and Euler's equation. Flow measurements. Velocity and acceleration field. Derivation of Reynolds transport theorem. Rayleigh's method and Buckingham's Pi theorem. Boundary layer theory.

Hydraulics and Pneumatics

Hydraulic and pneumatic devices, hydraulic and pneumatic valve types, configuration and characteristics responses, Design and application of hydraulic and pneumatic systems.

Recommended Books

1. Fundamentals of Fluid Mechanics by Bruce R. Munson, Donald F. Young and Theodore H. Oliishe, Wiley, Latest Edition.
2. Engineering Fluid Mechanics by Donald F. Elger, Barbara C. Williams, Clayton T. Crowe and John A. Roberson, Wiley, Latest Edition
3. Fluid Mechanics by F. M White, McGraw-Hill, Latest Edition
4. Pneumatics and Hydraulic Systems, by W. Bolton, Butterworth Heinemann Ltd., Latest Edition.
5. Fluid Mechanics and Hydraulic Machinery, by K. R. Arora, Standard Publisher, Latest Edition.

MTE-3xxINSTRUMENTATION AND MEASUREMENT

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives
To teach the operating principles of various types of sensors and to introduce the concepts & designs of instruments for the measurement of electrical and non-electrical quantities. Upon completion of this course, along with its lab sessions, students will also be able to select, interface and calibrate various types of sensors or instruments

Topics Covered

Measurements terminologies including resolution, sensitivity, accuracy, and uncertainty, engineering units and standards.

Principles of different measurement techniques. Sensors for measurement of temperature; Thermocouples, RTDs, Thermisters. Sensors for displacement and position; digital encoders, shaft encoders, absolute and relative encoders, linear encoders. Sensors for force, pressure, strain, vibration, velocity, flow rates etc.

Signal conditioning and filter design. Types of bridge circuits for measurement of resistance, inductance, and capacitance. Analog to digital conversion. Systems for signal processing and signal transmission. Data recording and data acquisition systems. Microprocessor based instrumentation circuits.

Techniques to select different sensors, sensor calibration.

Recommended Books

1. Klaas B. Klaassen and Steve Gee "Electronic Measurement and Instrumentation", Cambridge University Press, ISBN: 0521477298.
2. Fundamentals of Industrial Instrumentation and Process Control by William C. Dunn, McGraw Hill, ISBN: 0071457356 / 9780071457354
3. Kevin James, Newness "PC Interfacing and Data Acquisition Techniques for Measurements, Instrumentation and Control", Newness,
   ISBN: 0750646241.

ME-3xx THEORY OF MACHINES

Theory Cr Hrs, 2 **Lab Cr Hrs, 1**

Course objectives

The objective of the course is to introduce the preliminary concepts of mechanisms and to present methods of analysis for the motion and force transmission in mechanisms. After this course the students are able to understand the various independent technical approaches that exist in the field of mechanisms, kinematics, and machine dynamics.

Topics Covered

Kinematics Fundamentals, Degrees of Freedom, Different types of mechanisms, their characteristics and applications, Position, Velocity and Acceleration analysis, Dynamic force analysis, Static and dynamic balancing, Cam and gear (gear trains) design.

Recommended Books

1. Design of Machinery by R. Norton, McGraw Hill, Latest Edition.

2. Theory of Machines and Mechanisms by Joseph E. Shigley and John Joseph Uicker, McGraw Hill, Latest Edition.
3. An introduction to Synthesis and Analysis of Mechanisms and Machines by McGraw Hill Series in Mechanical Engineering, Latest Edition.
4. Mechanisms and dynamics of Machinery, by Hamilton H Mabie, John Wiley, Latest Edition.

GS-3xx NUMERICAL METHODS

Theory Cr Hrs, 2 **Lab Cr Hrs, 0**

Course Objectives

This course introduces students to a variety of numerical methods to solve a broad range of engineering problems.

Topics Covered

Floating Point number system, Stability of Algorithm and Error analysis, Iterative Methods for the Solutions of Non-Linear Equations, Fixed point Method, Newton-Raphson Method, Secant Method, Bisection Method, Regula-Falsi Method; Convergence, Interpolation: Lagrange Interpolation, Newton's Divided Difference, Forward Difference and Backward Difference Interpolations, Numerical Differentiation, Cubic Spline Interpolation, Numerical Integration: Rectangular, Trapezoidal and Simpson's Rules, Determination of Required Accuracy.

Numerical Methods in Linear Algebra. Systems of linear Equations, Gauss Elimination Method, LU Factorization: Doolittle's, Crouts's and Cholesky's Methods, Iterative Methods for Systems of Equations: Gauss-Seidel Method,

Jacobi's Method, Method of least squares, Evaluation of Eigen values by Iteration: Power Method, Eigenvectors.

Solution of 1^{st} and 2^{nd} Order Ordinary Differential Equations: Euler Method, Heun's Method, Runge-Kutta, Method, Runge-Kutta-Nystrom Method, Solution of Elliptic Partial Differential Equations, Laplace and Poisson Equations, Dirichlet Problem, Neumann and Mixed Problem, Irregular Boundary, Solution of Parabolic PDEs: Crank-Nicolson Method, Solution of Hyperbolic PDEs.

Recommended Books

1. Applied Numerical Analysis by Curtis F.Gerald Patrick O.Wheatley, Latest Edition.
2. Numerical Analysis for Applied Mathematics, Science, and Engineering by Donald Greenspan & Vincenzo Casulli, Latest Edition.

3. Numerical Methods and Software by David Kahaner, Latest Edition.

MTE-3xxMECHATRONICS SYSTEM DESIGN

Theory Cr Hrs, 2 **Lab Cr Hrs, 2**

Course Objectives

This course focuses on the synergetic integration of the knowledge of mechanical engineering, electronics, and computer engineering to achieve a functional mechatronic system. Students will practically develop systems like a position control system for a CNC XY-table, an autonomous robot, or any other mechatronic systems in the lab. Theory class is used for background knowledge required to design the system, perform numerical calculations and develop the design document.

Topics Covered

Optimum design process. What steps design engineers follow to design a system? Requirements analysis. Meeting standards. International standards for industrial equipment, embedded systems, standards for safety critical systems like robots and AGVs etc. Format and layout of Design Document.

Mechanical Design: Mathematical Model. General equation of motion for a mechatronic system. Estimating Motor torques based on inertia of the system and the desired maximum velocity and acceleration. Estimating frictional forces due to dry friction and misalignment. Designing for low friction and high-rigidity systems. Design of mechanical drive system. Ball screw design. Design of Linear Motion guides. Preparing workshop drawings of various mechanical components using CAD. Preparing part program files for CNC machining of components using G-Simple or any other CAD/CAM package. These drawings and CNC codes will later become part of the final design document.

Electronics and Software Design

Evolving schematic circuit diagrams for the electronic circuitry. H-bridge circuit design for servo motor control. Components selection. Development of computer hardware using modern microcontrollers or DSPs. Pulse encoder interface circuit. Implementation of PID control algorithm. Interfacing other sensors with the microcontroller. Path planning algorithm, trajectory generation. Front-end design. Data communication with other devices.

Course Project

Design and develop a CNC XY-table, an autonomous robot, or any other relevant mechatronic system in the lab and submit the design document in the given format.

Recommended Books

1. David Alciatore, “Introduction to Mechatronics and Measurement Systems” Latest edition2. Devdas Shetty and Richard Kolk “Mechatronics System Design”, Brooks/Cole CENGAGE Learning, Latest edition
2. Rajput, R K. “A Text Book of Mechatronics”, S. Chand & Company Ltd., Latest edition.
3. Saeed B. Niku “Introduction to Robotics Analysis, Systems, Applications”, Pearson Education Inc., NJ, USA, Latest edition.

MTE-3xx DESIGN OF MACHINE ELEMENT

Theory Cr Hrs, 2 **Lab Cr Hrs, 0**

Course Objectives

The objective of this course is to design common machine elements and to gain experience in solving design problems. This course also helps to prepare professional quality solutions and effectively communicate the results of analysis and design.

Topics Covered

Introduction to Static loading, Factors of safety, Failure Theories, Failure of Ductile/Brittle Materials, Stress concentration factor, Introduction to fatigue loading, S-N Diagram and loading, Stress concentration effect on fatigue failure, Fluctuating loading, Combined loading, Shafts loading and design considerations, Design of Screw, Fasteners Connections, Welded joints, Mechanical springs, Design and Stress Analysis of helical extension and Compression Spring, Bearing design covering, Gear fundamentals and Miscellaneous Topics such as Mechanical Elements

Recommended Books

1. Mechanical Engineering Design, by Joseph Edward Shigley, McGraw Hill, Latest Edition
2. Fundamentals of Machine Component Design, by R. C. Juvinall, and K. M. Marshek, John Wiley, Latest Edition

MTE-3xx MODELLING AND SIMULATION

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

The aim of this course is to introduce students the modeling of mechanical (translational and rotational) systems, electrical system, electro-mechanical system, fluid system, thermal system and other interdisciplinary system, with conventional modeling and other techniques like Monte Carlo methods.

Topics Covered

Modeling of mechanical systems (springs, dampers, mass, translational and rotational systems, geared systems), Modeling of electrical systems (capacitor, inductor, resistors, and analog electronic devices), Modeling of hydraulic and pneumatic systems, Mechatronics systems (Electro-mechanical, fluid –mechanical and Electro-hydraulic systems), System dynamic response analysis (frequency response),State space analysis, Numerical techniques, time response and digital simulation, stochastic simulation, Monte Carlo methods.

Recommended Books

1. Modeling and Simulation of Dynamics Systems, Robert L. Woods and Kent L. Lawrence, Prentice-Hall, 1997.
2. Modeling and Analysis of Dynamic Systems Latest Edition, by Charles M. Close, Dean K. Frederick, Jonathan C. Newell.
3. Modeling and Simulation of Systems Using MATLAB and Simulink Latest Edition, by Devendra K. Chaturvedi

ME-3xx FUNDAMENTALS OF THERMAL SCIENCES

Theory Cr Hrs,3 **Lab Cr Hrs, 1**

Course Objectives

This course gives introduction of basic concepts of thermodynamics, like system, surrounding, work, heat, modes of heat transfer and different process to the students. It will also introduce steady flow and non-steady flow processes and basic steam and gas turbine cycles.

Topics Covered

Basic Concept of Thermodynamics, Properties of Pure Substance, The First Law of Thermodynamics, The Second Law of Thermodynamics, Power and Refrigeration Cycle, Introduction to Heat Transfer, Conduction Heat Transfer, Convection Heat Transfer, Radiation Heat Transfer, Heat Exchangers and Cooling of Electronic Equipment

Recommended Books

1. Y.A., Introduction to Thermodynamics and Heat Transfer, Mc Graw Hill,2009.
2. Fundamentals of Thermodynamics, Richard E. Sonntag, Claus Borgnakke and Gordon J. Van Wylen, John Wiley & Sons, Latest Edition.
3. Lienhard and Lienhard. A Heat Transfer Textbook. 3rd ed., 2008.
4. Fundamentals of Engineering Thermodynamics by Micheal J. Moran and Howard N. Shapiro, John Wiley & Sons.
5. Engineering Thermodynamics by Merle C Potter and Craig W.

Somerton, McGraw Hill Companies Inc.

MTE-4xx ROBOTICS

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives

To develop a working knowledge of the mathematical aspects of robot manipulator analysis and control.

Topics Covered

Types of robots, Types of joints used in robots, Degree of freedom and constraints, Types of planar and spatial mechanisms, Transformations from one system to the other, Forward and Inverse kinematics, Jacobian, Velocity and Force Analysis, Dynamics of robots, Path planning and trajectory analysis, Mechanism design (serial and parallel) used in robots, Linear control of manipulators, Sensors and actuators used in robotics, current trends in robotics.

Recommended Books

1. Introduction to Robotics, by J. J. Craig, Addison-Wesley, Latest Edition
2. Introduction to Robotics, by O. Khatib and K. Kolarov, Latest edition
3. Robot dynamics and Control, by M. W. Spong and M. Vidyasagar, Wiley & Sons, Latest Edition
4. Robotics and Automation: An introduction to Cams, Mechanisms, and Robotics, by D. Tesar and S. Todunoglu., Latest edition 5. Robot Analysis: The Mechanics of Serial and Parallel Manipulators, by Lung-Wen Tsai, John Wiley & Sons, Latest edition

MTE-4xx CONTROL SYSTEMS

Theory Cr Hrs, 3 **Lab Cr Hrs, 1**

Course Objectives

The objective of the course is to teach the students about the basic analysis and synthesis tools used in the design of feedback control systems. The students are also familiarized with industry standard software tools such as Matlab®, Simulink®, Scilab, and/or Octave to analyze, design, and evaluate control systems.

Topics Covered

Basic Concepts of control systems, a quick review of mathematical modeling, Transfer functions, Block Diagrams and Signal Flow Graphs. Response of First and Second Order Systems, Asymptotic/BIBO Stability

and Routh-Hurwitz Stability Criterion. Performance Specifications of Linear Time-Invariant Control Systems, PID controller design, Root Locus Analysis, Root Locus Design, Frequency Response Analysis, Frequency Response Design, Bode plots, and Nyquist criterion. State space analysis and design.

Recommended Books

1. Design of Feedback Control Systems, by R. T. Stefani, C. J. Savant, B. Shahian, G. H. Hostetter, OUP, USA, Latest Edition.
2. Feedback control systems, by Phillips and Harbor, Prentice Hall, Latest Edition
3. Control Systems Engineering, by N. Nise, Wiley-VCH. Latest Edition
4. Modern Control Engineering, by K. Ogata, Pearson Education, Latest Edition
5. Modern Control Systems, by Richard C. Dorf, and Robert H. Bishop, Pearson Education Ltd., Latest Edition
6. Automatic Control Systems, by F. Golnaraghi, and Benjamin C. Kuo, JohnWiley & Sons, Latest Edition.

MS-4xx ENGINEERING ECONOMICS

Theory Cr Hrs, 3 **Lab Cr Hrs, 0**

Course Objectives

This course deals with the thought processes, concepts, methods, and knowledge bases used by engineers to cost engineering projects and to evaluate the merit of making a particular investment and to choose the best of a series of alternative investments to achieve a desired objective.

The theory of microeconomics makes use of the tools of marginal cost-benefit analysis to provide a framework for the economic analysis of decision-making. The focus is on the choices of individual firms and consumers, and the resultant outcomes in individual markets. The social implications of the functioning of competitive markets are examined, as well as the causes of market failure and the potential roles of government in correcting them.

At the end of this course, the student would have clear understanding of cost concepts, money time relationship, break-even analysis, benefit-cost analysis and depreciation.

Topics Covered

Introduction: Definition, decision-making process, relationship between engineering and management, and principles of engineering economy.

Cost concepts and analysis: terminology, application of cost concepts, and accounting and engineering economy studies. Money-time relationship: Time value of money, simple and compound interest, cash flow, single sums of money, uniform series of cash flows and equivalence. Basic methods: present worth, annual worth, future worth, internal rate of return, and external rate of return methods. Comparing alternative proposals: Present worth, Annual payments, future worth, and rate of return methods. Break-even analysis: break-even point, break-even involving income and cost analysis. Benefit-cost analysis: Comparing benefits of costs, B/C ratios, and methods for calculating B/C ratios. Depreciation: measuring depreciation, depreciation accounting and standard methods for calculating depreciation.

Recommended Books

1. Engineering Economy by DcGarmo, E. P., Sullivan G. W. and Bontadelli,
   A. J., Macmillan publishing company, Latest Edition.
2. Engineering Economic and Cost Analysis by Collier, A. C. and Ledbetter
   B. W., Harper and Row Publishers, New York, Latest Edition.
3. Principles of Engineering Economic Analysis, by White, A. J, Agee H. M. And Case, E. K, John Wiley and Sons, Latest Edition.

CSL-4xx Community Service Learning

Theory Cr Hrs, 1 **Lab Cr Hrs, 1**

Course Objectives

Community Service Learning course is compulsory for all students. The aim is to impart general awareness and knowledge along with social guidance to develop students into socially active citizens in line with Community Service strategy of having discernible positive impact on society through active citizenry.

Topics Covered

1 credit hours: Comprising of 16 hours of workshop related to the topics listed below or any other relevant topic
Workshop 1: Deriving Inspirations for Community Service
Workshop 2: Community Service Project Management
Workshop 3: Disaster Response and Recovery
Workshop 4: First aid and Fire fighting
Workshop 5: Social Entrepreneurship
Workshop 6: Application of your respective school"s/ institution's field in community service

1 credit hour of field work comprising of:

- 1st assignment of 10hrs – community service focused
- 2nd assignment of 20 hours – community development/ empowerment focused

More than 2 activities possible against each assignment but reporting in the same document

Group activities are advisable for both assignments

Grading and Evaluation

Grade S- Satisfactorily Completed: Students completing all of the course requirements satisfactorily

Grade P- Participated: Students not completing all course requirements but participating with zeal and motivation

Not completing the course requirements: Course is not to be mentioned in the transcript

University may give award to the best community service project during convocation or any other ceremony.

Recommended Books

1. Service- Learning: History, Theory and Issues, By Bruce W. Speck, Sherry L. Hoppe

MTE-4xx MANUFACTURING AUTOMATION

Theory Cr Hrs, 2 **Lab Cr Hrs, 1**

Course Objectives

The course covers industrial automation with particular reference to CNC and PLC. After this course, the students would be able to understand the automation requirements of a modern industrial set-up.

Topics Covered

Industrial and specially Manufacturing Automation, Automation Theory;

Computer Numerical Control (CNC) Machining Requirements, Limitations of Conventional Machining, Introduction of Numerical Control, Building blocks of CNC, CNC Programming, Machining Codes, Sensors/actuators/control cards used in CNC machines.

Programmable Logic Controllers (PLC)

Introduction to PLC, PLC Architecture and Operation, Advantages / Limitations of PLC, Ladder Logic and other Programming Formats, Relay Logic, Timers, Counters, Comparator, Math Instructions, Bit Shift Registers, Advanced instructions, industrial data communication

protocols, SCADA, HMI.

Recommended Books

1. Jon Stenerson, “Fundamentals of PLCs, Sensors and Communication”, 3rd Ed., Prentice Hall, Upper Saddle River, New Jersey, 2004
2. Robots and Manufacturing Automation, by C. Ray Asfahl, John Wiley & Sons, Latest Edition
3. CAD/CAM Principles and Applications, by P N Rao, McGraw Hill, Latest edition
4. Programmable Controllers, by E. A. Parr, Newnes, Latest edition
5. Automation Production Systems and Computer Integrated Manufacturing, by Mikeel P. Groover, Prentice Hall, Latest Edition
6. Machine Tool Technology Basics bySteve Krar, Arthur Gill, Peter Smid and Paul Wanner, Latest edition

MTS-4xx Senior Design Project

Theory Cr Hrs, 0 **Labs Cr Hrs, 3+3**

Course Objectives

The Senior Design Project introduces students to independent design and development project. It exposes the students to the existing problems and issues related to implementation of Mechatronics engineering projects. It is a team based project that gives ample opportunities to the students to demonstrate their engineering knowledge, skills, leadership, team work and some of graduate attributes that are the program learning outcomes of Mechatronics Engineering.

Topics Covered

Analysis of complex engineering problems, literature review including developments in chosen technical area, Briefing and Project Selection, Design solutions for complex engineering problems and design systems, use of modern equipment to experimentally validate the theoretical concepts , recognize importance of, and pursue lifelong learning, teamwork, Report writing, Oral Presentations, Research paper writing.

Recommended Books

1. Systems Engineering by Ian Faulcon bridge and M J Ryan, Argos press, 2014.
2. Lateral Thinking by Edward De Bono, Latest edition

ENGINEERING ELECTIVES

Electives can be offered as 3-0 CH or 2-1 CH depending on the availability of Labs, equipment, faculty and other resources.

MTE-4xx MECHANICAL VIBRATIONS

Course Objectives

This course gives knowledge of vibrations in rotating and oscillating bodies.

Topics Covered

Fundamentals of vibration, classification of vibration, analysis and elements of vibratory system. Simple harmonic analysis, Un-damped and damped free vibration, introduction to forced vibration with harmonic excitation. Forced vibration with Viscous and Coulomb damping, self-excitation stability analysis, whirling of rotating shafts. Balancing of rotator machinery, coordinate coupling, principle coordinates, and multi degrees of freedom system. Numerical techniques used in vibration, such as, Holzer method, Influence Coefficient, and Eigen value problems.

Recommended Books

1. Mechanical Vibrations, by Singiresu S. Rao, Pearson education publishing company, Latest Edition.
2. Vibration theory and applications, by William T. Thomson, Lewis reprints limited, Latest Edition.
3. Mechanical Vibrations, Schuam's outline series in Engineering, by Seto. Latest Edition.

MTE-3xx POWER ELECTRONICS

Course Objective

To teach electronic devices and circuits used in power electronic applications.

Topics Covered

Power electronic devices; power diode, power MOSFET, SCR, GTO Thyristor, IGBT, TRIAC, DIAC. Thyristor gate drive and commutation circuits, low-side and high-side drives. Uncontrolled, semi-controlled and fully-controlled rectifiers, single-phase and three-phase rectifiers. AC choppers. Pulse width modulation (PWM). Inductor design for switching applications, DC-to-DC converters; buck, boost, buck-boost, Cuk converters, resonant converters. H-bridge circuit design. Switched mode power supplies. Pulse-width-modulated (PWM) amplifiers/inverters (single

and three-phase).DC motor drives. Stepper motor drives. UPS (square-wave, quasi sine/square-wave and sine-wave).AC motor drives. Industrial heating; induction furnace, dielectric furnace etc. Practical/commercial devices for PWM generation, high-side drives, switching regulators etc.

Recommended Books

1. M.S. Jamil Asghar, "Power Electronics" Prentice Hall India, ISBN: 81-20-3-2396-3.
2. Ned Mohan, William P. Robbins and Tore M. Undeland, "Power Electronics: Converters, Applications and Design," Media Enhanced, Third Edition, 2003, John Wiley & Sons, ISBN: 0471429082.
3. Cyril W. Lander, "Power Electronics," Third Edition, 1993, McGraw-Hill UK, ISBN: 0077077148.
4. Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications," Third Edition, 2004, Prentice Hall, ISBN: 0131011405.
5. B. K. Bose, "Modern Power Electronics and AC Drives," Prentice Hall,
   ISBN: 013-0167436.

MTE-4xx DIGITAL IMAGE PROCESSING

Course Objectives

To develop thorough understanding of digital image processing fundamentals, properties of discrete transforms and their importance, study of various image enhancement techniques in spatial and frequency domains, fundamentals of image compression, introduction to color image processing, wavelets and morphological image processing.

Topics Covered

Introduction to Digital Image Processing:

Digital Image Representation, Acquisition, Storage, Processing, Communication and Display.

Digital Image Fundamentals

Visual Perception, Issues in Sampling and Quantization of a digital image, Connectivity and relations between pixels.

Image Enhancement

Spatial and Frequency Domain methods, Enhancement by point processing, Histogram processing, spatial filtering techniques, Enhancement in Frequency domain, frequency filtering techniques.

Image Transforms

Discrete Fourier Transform, Properties of 2-D Fourier Transforms, Fast Fourier transform (FFT), Discrete Cosine Transform (DCT).

Image Restoration

Degradation model, Spatial and frequency domain filtering, inverse filtering, Weiner filters.

Colour Image Processing

Fundamentals of colour image processing, colour models.

Image Compression

Types of redundancy, fidelity criterion, study of error free compression and lossy compression techniques; their merits and demerits, Image Compression Standards.

Wavelets & Morphology

Introduction to wavelets and their application in image compression, some basic morphological algorithms.

Recommended Books

1. Digital Image Processing by Rafael C. Gonzalez, Richard E. Woods, Addison Wesley, 2ed. 2002.
2. Digital Image Processing by Kenneth R. Castleman, Prentice Hall International Edition, 1996.
3. Digital Image Processing Using Matlab by Rafael C. Gonzalez and Richard E. Woods, Pearson Education, 2004.

MTE 4xxEMBEDDED SYSTEMS

Course Objectives

This course is designed to develop a standalone application using modern embedded devices.

Topics Covered

Introduction to embedded systems, Hardware architecture for embedded systems: Programmable logic devices like, Programmable array logic (PAL) Programmable logic array (PLA), complex Programming logic device (CPLD), Application Specific Integrated Circuits (ASIC) and Field Programmable Gate Arrays (FPGA). Software for embedded systems: Introduction to development environment: FPGA development kit (Spartan-III), Introduction to Verilog, Development of various applications like Mux, Demux, counters, registers, ALU etc. Development of an image

processing system using FPGA.

Recommended Books

1. Computer Architecture, A Quantitative approach by Dr. David A. Patterson and Dr. Paul Hennessey,- Digital Computer Electronics by Malvino & Brown.
2. Embedded System Design: A unified Hardware/Software Introduction. By Frank Vahid & Tony D. Givarigis.
3. Embedded System Design. Hardware/ Software System, by P. Marwedel
4. FPGA prototyping by VHDL examples: Xilinx Spartan-3 version, By Pong P. Chu - Wiley-Interscience.

MTE-4xx DIGITAL CONTROL SYSTEMS

Course Objectives

This course covers the basic and advanced theory about the analysis and design of digital control or sampled-data systems as well as use of digital computers in the real time control of dynamic systems. At the end of this course student should be able to analyze the digital and sampled-data system and understand the effects of quantization and sample rate etc.

Topics Covered

Problem definition, overview of design approach, Review of continuous Control, Introductory Digital Control: Digitization, effect of sampling. Discrete system analysis; linear difference equations, discrete transfer function, Block diagram, external stability. Discrete models of sampled-data systems; using z-transform, continuous time delay. Signal analysis and dynamic response; unit impulse, unit step, exponential, general sinusoid, step response, frequency response, Discrete Fourier Transform. z-transform, solution of difference equation, Modified z-transform, properties of z-transform, convergence of z-transform, inversion. Sampled data system; Analysis of sample & hold, spectrum of a sampled signal, block diagram, analysis of sampled-data system, Calculating the system output between samples, Discrete Equivalents; zero-pole matching equivalents, hold equivalents. Design using Transform Techniques; z-domain root locus, z-domain digital controller design, Frequency response methods; Nyquist stability criterion, design specifications in frequency domain, compensator design. Quantization Effects; Analysis of round-off errors, effects of parameter round-off, Sample rate Selection, Sampling Theorem, Sensitivity to parameter variations, multi-rate sampling.

Recommended Books

1. Digital Control of Dynamic Systems, by Gene F. Franklin, J. David

Powell and Michael L. Workman, Addison Wesely, Latest Edition.

2. Digital control Engineering, analysis and design, by M. Sami Fadali and Antonio Visioli, Eslevier Latest Edition.
3. Control System Design using MATLAB, by Bahram Shahian and Michael Hassul, Prentice-Hall Latest Edition.

MTE-4xx POWER PLANT SYSTEMS

Course Objectives

This course introduces the power conversion of steam, nuclear and gas turbine cycles and its applications in Mechatronics Engineering.

Topics Covered

Internal Combustion Engines:
Various components and working of IC Engines, Auxiliary systems, Criteria of Performance, Engine Output and Efficiency, Performance characteristics.

Steam Power Plants
Steam Generators; Rankine cycle, Rankine cycle with superheat, and reheat cycles. The Reciprocating Steam Engines.

Combined Cycle Power Plants
General, Combined Cycle with heat-Recovery Boiler Combined Cycle with Multi Pressure Steam. Steam Cycles for Nuclear Power Plant, Combined Cycle for Nuclear Power Plants.

Gas Turbine Cycles
The Components of Gas Turbine Power Plant, Air Brayton cycle for power plant and for Jet Engines.

Reciprocating and Turbo Machinery
Introduction to Reciprocating Compressors, Centrifugal Compressors, Multi-Stage Compression, Vacuum Pumps, Air Motors. Rot Dynamic Machines for Steam and Gas Turbine Plants; Pumps.

Recommended Books

1. Fundamentals of Classical Thermodynamics, By Gordon J. Van Wylen and Richard E. Sonntag. Wiley International Edition.
2. Engineering Thermodynamics Work & Heat Transfer, by G. F. C Rogesand Y. R. Mayhew, Longman.
3. Fundamentals of Engineering Thermodynamics by Micheal J. Moran and Howard N. Shapiro, John Wiley & Sons.
4. Applied Thermodynamics for Engineering Technologists, By T. D Eastop and A: Mc-Conkey, Longman.
5. Engineering Thermodynamics by Merle C Potter and Craig W. Somerton, McGraw Hill Companies Inc.

EM-4xx SPECIAL TOPICS IN MECHATRONICS

Course Objectives

In this course three modules are selected. The main objective of the course is to introduce the students to finite element analysis using latest simulation software, internal combustion engines and latest trends in automotive industry, and mechanical turbo machinery systems.

Topics Covered

Introduction to Finite Element Analysis and its application, One dimensional Finite Elements, Two dimensional Finite Elements, Dynamic Analysis in Finite Element System, Ansys Software, Overview of IC Engines, Intake and Exhaust Systems + Air fuel ratios, Carburetors, Fuel Injection and Ignition Systems, Cooling and Lubrication Systems, Turbines, Pumps, Compressors, Refrigeration System.

Recommended Books

1. Fundamental of Fluid Mechanics by Bruce R.Munson, Donald, F.Young and Theodore H.Okishhi, Latest Edition.
2. Automotive Technology: A Systems Approach by Jack Erjavec, Latest Edition.
3. Finite Element Analysis, Theory and Applications with ANSYS, by Saeed Moaveni.

MTE-4xx Digital FILTER DESIGN

Course Objectives

To introduce signal processing with an emphasis on digital signal processing and teach the filter design, time-domain and frequency-domain analyses of continuous-time and discrete-time systems. In this course one will also learn when to choose an IIR and when an FIR filter, and how do you design FIR and IIR filters from specifications on amplitude performance?

Topics Covered

Types of signals; signal representation and models; system characterization; time domain analysis; frequency domain representation and analysis; continuous-time filters; sampled continuous-time signals; Discrete Fourier transform and its properties; Fast Fourier transform algorithms; inverse transform techniques; implementation of discrete-time systems; DSP chip classifications; DSP block diagram; hardware interfacing techniques of DSP; FIR and IIR filter design using DSP; image processing and other practical applications of DSP, and also an introduction to adaptive filter.

Recommended Books

1. Simon Haykins “Signals and Systems”, John Wiley and Sons, USA, 2nd ed. 2003.
2. Rafael Gonzalez and Richard Woods “Digital Signal Processing”, Prentice Hall, ISBN: 0201180758, 2nd edition, 2002.

MTE-4xx INTERNAL COMBUSTION ENGINES

Course Objectives

To make students familiar with the design and operating characteristics of modern internal combustion engines. To apply analytical techniques to the engineering problems and performance analysis of internal combustion engines. To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions. To introduce students to the environmental and fuel economy challenges facing the internal combustion engine.

Topics Covered

Classification/ Working of Internal Combustion Engines, Engine Performance Parameters, Air Standard Cycles (Otto, Diesel, Dual), Thermochemistry and Fuels, Air and Fuel Induction, Exhaust Flow, Emissions & Air Pollution, Friction and Lubrication

Recommended Books

1. Internal Combustion Engines: Applied Thermo sciences, Colin R. Ferguson, Allan T. Kirkpatrick, 2nd Edition, Wiley
2. Edward F. Obert, Internal Combustion Engines and Air Pollution, Harper & Row NewYark.

MTE-4xx AUTOMOTIVE TECHNOLOGY

Course Objectives

To familiarize the students with the knowledge and working of an internal combustion engine. To give practical insight into various parts of the automobile and appreciate the intricacies of the product. To study the performance and troubleshooting of various parts of an automobile.

Topics Covered

Fundamentals, operations, types, performance measurements, Electrical System, Battery, Starting, Charging, Ignition, Testing instruments, tune-up, Si engine diagnosis, Service of valves, pistons, crankshafts and bearings, Clutch, Transmission (manual and automatic), Transfer Case, Differential, Suspension, Steering, Brakes, Heating, Air-conditioning

Recommended Books

1. W.H. Crouse & D.L. Anglin – Automotive Mechanics, (10th Edition), McGraw-Hill, New York, 1993
2. Principles of Automotive Vehicles, US Army TM 9-8000, Washington DC, 1985

MTE-3xx ELECTRICAL INSTRUMENTATION

Course Objectives

This course deals with the study of sensors, transducers and measuring instruments. Specific objectives are to help students to learn: The principles of DC and AC analogue measuring instruments, the interfacing of different type of sensors and transducers and applications of different measuring instruments.

Topics Covered

Unit Dimension and Standards. Fundamental and derived units, electrical units, frequency voltage, current, resistance, capacitance and inductance standards. Language of measurement, decibel, DC Indicating Meters. Thed'Arsonval movement, galvanometer, DC ammeters, DC voltmeters, resistance measurements, DC meter calibration, AC Indicating Meters. Half wave and full wave rectifier meters, electrodynamometer, single phase wattmeter, energy measurement meters, instrument transformers, Analog Electronic Meters. Transistor voltmeter circuits, operational amplifier voltmeter circuits, AC electronic voltmeters, current and resistance measurement, Bridges and Potentiometers: Wheatstone bridge. Kelvin Bridge. A.C. bridges and their applications. A.C and D.C. potentiometers, Digital Meters. Overview of A/D and D/A converters, digital voltmeter system, frequency meters, current measurement, Transducers. Selection consideration, Resistance temperature detector, thermistors, strain gauges, Photoconductive transducers, thermocouples, piezoelectric and magnetic induction and capacitive transducers, capacitive and inductive measurement, Transducer Interfacing. Signal conditioning, analog interfacing of transducers, loading effect, digital interfacing (using parallel and serial ports), the current loop, Introduction to Measuring Instruments. Oscilloscopes, signal generators, graphic-recording instruments, spectrum and logic analyzers. Instrument calibration.

Recommended Books

1. Principles of Electronic Instrumentation and Measurement, by Berlin& Getz.
2. Electronic Instrumentation and Measurement, by David A Bell
3. Electrical and Electronic Measurement & Testing, by W Bolton

MTE-4xx LASER AND ITS APPLICATIONS

Course Objectives
The objective of this course is to introduce the students to the concept of Lasers and the various applications they are used in.

Topics Covered
Laser principles, Lase History, Laser light and Gaussian beams, Laser resonators, Laser medium, Laser diagnostics and applications, Holography, Optical communication, CD-DVD players, Liquid crystals, Lasers with environmental techniques, Laser welding, drilling and cutting, LIBS-methodology in material science, Lasers in medicine, Laser ionization, Laser fusion

Recommended Books
1. Introduction to Lasers and Their Applications by O'Shea, Callen& Rhode, Latest Edition.
2. Optical Electronics by A Yariv, 4th Edition.

MTS-4xxFUZZY LOGIC

Course Objectives
To familiarize students to understand fuzzy sets and modeling using fuzzy rules, to Understand the modules of a fuzzy logic controller (FLC): fuzzification, inference and Defuzzification, to Understand the design of a P, PD, PI and PID fuzzy controller, to Understand algorithms that learn and adapt fuzzy membership functions and rule bases

Topics Covered
Fuzzy Sets and Operations on Them, Fuzzy Relations, Fuzzy Rules, Approximate Reasoning, Fuzzy Logic, Fuzzy Systems (e.g., Fuzzy Logic Control), Neural Networks Single /Multi layered, Neural Fuzzy Inference System

Recommended Books

1. Fuzzy Sets & Fuzzy Logic Theory & Applications, by J. Klir& Bu Yuan, Prentice Hall Inc., 1995.

MTE-4xx APPLIED ROBOTICS

Course Objectives
To develop an understating of the control topologies and parameters required in modern manipulators and mobile robots and be able to apply these controls to real-world robotic manipulators and platforms.

Topics Covered

Kinematic and dynamic modelling of mobile platforms, Kinematic and dynamic models of serial chain manipulators, Trajectory planning of serial chain manipulators, Path planning of mobile platforms, Feedback control topologies, Digital implementation of control laws, Model identification, Parameter estimation techniques, Robotics and the industry

Recommended Books

1. Robotics, Vision and Control: Fundamental Algorithms in MATLAB (Springer Tracts in Advanced Robotics) by Peter Corke
2. Kinematics, Dynamics, and Control (2nd Edition) by Jazar, Reza N.
3. A Mathematical Introduction to Robotic Manipulation by R. M. Murray, Z. Li, S. S. Sastry

MTE-4xx MECHATRONICS MODELLING FOR AUTOMOTIVE SYSTEMS

Course Objectives

One completing this course students should be able to identify and explain the different analogies that can be made between all system dynamics, use fundamental concepts of mechatronics systems to derive and apply simplified system dynamics models, evaluate and construct mechatronics models using Bond Graphs and interpret the simulation results accordingly, derive state-space equations from Bond Graphs for the purpose of control system design, critically evaluate mechatronics models and the simulations results obtained within the context of practical automotive design concepts, performance and constrains.

Topics Covered

An Overview of System Dynamics and Mechatronics Systems, Elementary Mechanical Systems, Elementary Electric Circuits and Networks, Basic Techniques of Equation Formulation, The evaluation of existing and future active safety systems, Introduction to a Bond Graphs Simulation Tool, The evaluation of existing and future trends in engine, transmission and integrated powertrain control techniques, General Modelling of Mechatronics Systems: Sensors, Transducers, Conventional Powertrain, Alternative Powertrain

Recommended Books

1. Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach by Amir Khajepour, M. Saber Fallah, Avesta Goodarzi
2. Mechatronic Systems Techniques and Applications, Cornelius T. Leondes.

MTE-4xx POWER TRAIN SYSTEMS

Course Objectives

At the end of the course the students will be able to, understand the mechanics of powertrain systems for automotive applications, Evaluate the impact of powertrain systems on global emissions, Understand the systems view of engine technology, have the knowledge of automotive transmissions

Topics Covered

- The module includes a systems view of engine technology including:
  - Performance and emissions targets
  - Engine layouts & thermodynamic cycles
  - Fuels and emission
  - Engine downsizing for hybrid vehicles
- The module includes a systems view of alternative power train systems including:
  - Powertrain architectural options for electric vehicles, hybrid electric vehicles (series, parallel and complex) and plug-in hybrid electric vehicles
  - Hybridization ratio
  - Fuel economy measurement and metrics
- The module includes a systems view of automotive transmission including:
  - Gearbox layout and gear change mechanisms
  - Epicyclical gears, torque converter, gear combinations & configurations
  - Automated manual & dual clutch transmissions
  - Continuously variable transmissions.

Recommended Books

1. Vehicle Powertrain Systems: Integration and Optimization by David Crolla, Behrooz Mashadi Amir Khajepour
2. Automotive Engineering: Powertrain, Chassis System and Vehicle Body by David Crolla

HS-2xx PROFESSIONAL ETHICS

Course Objectives

The aim of this course is to examine the role and purpose of professional ethics. To present methods of moral reasoning, case analysis, and of resolving ethical dilemmas. To present Islamic values considered especially relevant to business activity.

Topics Covered

Introduction to Definitions/Importance/Kinds, Factors/Sources of Islamic Ethics, Moral Theories of Ethics about Major Ethical theories/Islamic Principles of Ethics, Islam VS Major ethical theories, Islamic ethical system, Axioms of Islamic ethical Philosophy, Ethics in Business, Enforcement of ethical environment/Factors, Principles & Decision Making, Islamic rules for business, Lawful and unlawful behavior in Islam, Halal and Haram business/Islamic principles, Engineering Ethics, Scope & Aims, Theories, responsibilities, IEEE code of Ethics, Ethical code for engineer, Ethical code for Software engineers, Moral Courage, Moral courage, its importance and how to improve Attributes of morally courageous.

Recommended Books

1. Engineering Ethics, Concepts & Cases by C. Harris Words Worth, 1994, Islamic Education, Latest Edition.
2. Ethics Engineering (Latest Edition) – Mike W. Martin.
3. Business Ethics (A stake Holder & Issues Management Approach) Latest Edition by Joseph W. Weiss, Contemporary Moral Issues by Lawrence M. Prentice

MS-4xx ENGINEERING MANAGEMENT

Course Objectives

Engineering Management is a specialized form of management that is required to successfully lead engineering or technical personnel and projects. The term can be used to describe either functional management or project management.
Engineering managers typically require training and experience in both general management and the specific engineering disciplines that will be used by the engineering team to be managed.

The successful engineering manager must have the skills necessary to coach, mentor and motivate technical professionals, which are often very different from those that are required for individuals in other fields.

Topics Covered

Concept of a project and its definition, Introduction to planning, scheduling and control of projects, Network model and its applications. Probabilistic and Deterministic Approaches. Gantt charts, PERT and CPM. Network simulation, latest software on project management, Determination of resources requirements of a project, Work Breakdown Structure (WBS), Request for Proposal (RFP), Resource leveling, Project scheduling under limited resources. Project crashing and alternatives analysis. Case studies

and Problem Solution.

Recommended Books

1. Production and Operations Management by Alan Muhlemann, John Oakland and Keith Lockyer 1995 Reprint, Sixth Edition, Pitman Publishing, London.
2. Engineering Economy by E. Paul DeGarmo, William G. Sullivan and John R. Canada 1984, Sixth Edition, Macmillan Publishing Company, New York/London.

MTE-4xx PRECISION MANUFACTURING

Course Objectives

In high value added manufacturing industry, engineers are required to understand how mechanical systems and materials behave at length scales of microns and nanometers. The objective of this course is to develop the student's skills and knowledge in precision engineering, micro and nano-engineering. The course will consider selected topics in precision, micro and nano-manufacturing, ranging from enabling technologies and processes to applications. Examples including precision machine design, metrology, coatings, and nano materials will be considered.

Topics Covered

Laser technology in micro and nano-manufacturing, IC and MEMS Manufacture, Precision machine design, Measuring at the micro and nano scale, Polymer nano-composites, nano materials and coating materials, Bio-nano-technology and Bio-mimetics The lab work may include Technology demonstrations with emphasis on Microscopy and analysis Recommended

Recommended Books

1. Kalpakjian & Schmid, 2006, Manufacturing Engineering &Technology, Pearson pub
2. Dornfeld & Lee, 2007, Precision Manufacturing, Springer pub
3. Additional reading Journal papers on micro-manufacturing Laboratory

MTE-3xx ENERGY RESOURCES AND MANAGEMENT

Course Objectives

Energy and Resources and management is a course that provides students with a thorough knowledge of sustainable management of energy and natural resources. The course covers theory, with a focus on modern issues. Leading academics with strong industry links and industry professionals contribute to all taught courses.

Topics Covered

Introduction to Energy, Technology and Human Society, Energy Resources, Production and Consumption, Energy Economics: Effect on Industry & National Economy, Energy: Effect on Environment, Energy: Policy & Regulation, Energy Efficiency: Trends, Benchmarking, Auditing & Incentives, Energy Management: Efficient Energy Conversion Technology, Energy Management: Cleaner Production & Energy Conservation, Energy Management: Renewable Energy (Biomass, Wind, Geothermal, Tidal, Solar and Hydropower), Guest Lecture and Industrial Visit

Recommended Books

1. J.A. Fay and D.S. Golomb: "Energy and the Environment", Oxford, 2002
2. Edward S. Cassedy and Peter Z. Grossman: "Introduction to Energy: Resources, Technology & Society", 2nd Edition, Cambrdige Press, 2003.
3. Harold H. Schobert: "Energy & Society", Taylor & Francis, 2002

MTE-3xx CONDITION MONITORING

Course Objectives

The objective of the course is to provide a basic knowledge and understanding of the techniques and technologies concerning condition monitoring of rotating and reciprocating machines, primarily through vibration analysis.

Topics Covered

Overview of condition monitoring and vibration analysis; Maintenance Practices; vibration sensors, transducers and data acquisition; Introduction to signal processing; Fast Fourier Transform (FFT); Introduction to rotor dynamics; fault diagnostics of hydrodynamic and roller element bearings; fault classification techniques; Introduction to miscellaneous health monitoring techniques such as oil analysis and temperature monitoring.

Recommended Books

1. Randall, R. B., Vibration-based Condition Monitoring: Industrial, Aerospace and Automotive Applications, 1st Edition, Wiley, 2011
2. Brandt, A., Noise and Vibration Analysis: Signal Analysis and Experimental Procedures, 1stEdition, Wiley, 2011
3. Shin, K. and Hammond, J. K., Fundamentals of Signal Processing for Sound and Vibration Engineers, 1stEdition, Wiley, 2008.

MTE-3xx BIOMECHATRONICS

Course Objectives

The course focuses on Biomechatronic systems including medical devices of biomedical nature which serve as the backbone patient care and medical support especially in rehabilitation medicine. This course will combine medical science and mechatronics to better understand the need and will give students a fundamental understanding of designing Biomechatronic systems.

Topics Covered

Introduction, Human Motion Control, Lower Extremity Orthotics and Prosthetics, Rehabilitation of patients with motor disorders, Artificial mechanical systems for the upper extremities, Control interfaces for mechanical devices, Actuators for mechanical devices, Exo-skeletons, Clinical gait analysis, Motor control in patients with neurological disorders, Artificial sensoric interfaces, Artificial motor control, Functional Electrical Stimulation (FES), Rehabilitation Robotics

Recommended Books

1. Graham M. Brooker, Introduction to Biomechatronics: The Application of Mechatronic Engineering to Human Biology, SciTech Publishing, 2012
2. D.B. Popovic and T. Sinkjae, Control of Movement for the Physically Disabled, Springer (2000), ISBN-13: 978-1852332792
3. Myer Kutz, Editor, Biomedical Engineering and Design Handbook, Second Edition, Volume 1: Fundamentals, McGraw-Hill Companies, 2009.
4. D.H. Plettenburg, Upper Extremity Prosthetics. Current status & evaluation, VSSD (2006), ISBN-13: 978-9071301759
5. Mark J. Schulz, Vesselin N. Shanov, Yeoheung Yun, Nanomedicine Design of Particles, Sensors, Motors, Implants, Robots, and Devices, Artech House, 2009.

MTE-3xx INTELLIGENT SYSTEMS

Course Objectives

Intelligent Systems, provides students with a working knowledge of methods for design and analysis of robotic and intelligent systems. Particular attention is given to modeling dynamic systems, measuring and controlling their behavior, and making decisions about future courses of action. The content is necessarily broad, and the course level is introductory. The intent is to motivate and prepare students to conduct research projects and for further study through advanced courses in related areas.

Topics Covered

System Modeling, Biological and Cognitive Paradigms**,** Dynamical Systems**,** Turing Machines and Concepts of Machine Intelligence**,** the Declarative-Procedural-Reflexive Hierarchy**,** Intelligent Agents
Principles of Control, Open- and Closed-Loop Control**,** Optimality and Constraints**,** Stability and Performance**,** Control Actuation
Principles of Measurement and Estimation, Sensors and Sensing**,** Probability and Error Models, Sensor-based Estimation**,** Classifiers**,** Vision and Image Analysis
Principles of Decision-Making, Crisp and Fuzzy Logic, Decision Trees, Case-based Reasoning, Bayesian Belief Networks**,** Path Planning**,** Voronoi Diagrams
Numerical Methods, Evaluation and Search, Monte Carlo Simulation, Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization
Neural Networks, Static Networks, Associative Networks, Cerebellar Model Articulation Controller
Expert Systems, Production Systems, Forward Chaining, Backward Chaining

Recommended Books
Robotics and Intelligent Systems
1. Robert Stengel, Robotics and Intelligent Systems: A Virtual Reference Book, (http://www.princeton.edu/~stengel/RISVirText.html)
2. S.J. Russell and P. Norvig. Artificial Intelligence: A Modern Approach (3rd edition), Prentice-Hall, 2010.

MTE-4xx ADVANCED CONTROL SYSTEMS

Course Objectives
A first level course on nonlinear control design methods, with a particular focus on adaptive control and estimation and also incorporating advanced analysis techniques for nonlinear systems.

Topics Covered
Introduction to nonlinear and adaptive control, Weak Lyapunov functions, LaSalle and Barbalat, Connection with Observability, Minimum Phase Systems and Universal Regulators, Universal Regulators for scalar plants, Relative Degree and Minimum-phase, Lyapunov-based Design, Control Lyapunovfunctions, Backstepping, Integrator Backstepping, Adaptive Integrator Backstepping, Parameter Estimation, Gradient Method, Adaptive Laws with Normalization, Sufficiently rich signals, Input-to-state stability, ISS stabilization, Adaptive ISS Controller Design, Stability of slowly time-varying systems, Application to Adaptive Stabilization,

Detectability, Switching Adaptive Control, The supervisor, Modular Design, Singular Perturbations, Unmodelled Dynamics, Singular Perturbations, Direct MRAC with Unmodelled Dynamics.

Recommended Books

Robotics and Control Systems

1. P. A. Ioannou, J. Sun, Robust Adaptive Control, Prentice-Hall, 1996S.J.
2. H. K. Khalil, Nonlinear Systems, Prentice-Hall, 2002 (third edition). On reserve at Grainger for ECE 528.
3. M. Krstic, I. Kanellakopoulos, P. V. Kokotovic, Nonlinear and Adaptive Control Design, Wiley, New York, 1995.

MTE-3xx DATA COMMUNICATION AND NETWORKING

Course Objectives

To introduce the concepts of basic data communication and networking to students, familiarize them with basic network architectures and operations, touch on some of the current problems and new applications in networks, cover all layers of the OSI model and relate them to real applications such as telecommunication networks, internet etc.

Topics Covered

- Network services and applications: DNS, HTTP, peer-to-peer systems, socket programming (Layers 4 and 5 of simplified OSI model)
- Network transport architectures, TCP, UDP, TCP congestion control (Layer 4)
- Routing and forwarding, intra-domain and inter-domain routing algorithms (Layer 3)
- Link layers and local area networks, especially Ethernet and WiFi (layer 2)
- Label switching(Layer 2.5)
- Physical layer and its real world applications (glass, copper, wireless) (layer 1)
- Wireless networks and technologies such as CDMA, TDMA, GPRS, Edge etc.
- As time permits:
    - Software-defined networking and network function virtualization
    - The Internet of Things (IoT)
    - Multimedia communications and quality of service
    - Network measurement, inference, and management
    - Network experimentation and performance analysis

- Network security
- Protocol verification

Recommended Books

1. James F. Kurose and Keith W. Ross. Computer Networking - A Top Down Approach, Latest edition
2. Computer Networks: A Systems Approach. L. Peterson and B. Davie.
3. Advanced Programming in the UNIX Environment. Stevens (updated by Rago).
4. The Art of Computer Systems Performance Analysis. Raj Jain.
5. An Engineering Approach to Computer Networking. Srinivsan Keshav.
6. Mathematical Foundations of Computer Networking. Srinivsan Keshav. Videos YouTube lectures
7. UNIX Network Programming, volumes 1 and 2. Stevens.
8. Data Networks. Dimitri P. Bertsekas, Robert Gallager.
9. Wireless Communication and Networks, Latest Edition., William Stallings.

MTE-4xx MOBILE ROBOTICS

Course Objectives

The objective of this course is to provide the basic concepts and algorithms required to develop mobile robots that act autonomously in complex environments. The main emphasis is put on mobile robot locomotion and kinematics, environment perception, probabilistic map based localization and mapping, and motion planning. The lectures and exercises of this course introduce several types of robots such as wheeled robots, legged robots and drones.

Topics Covered

Introduction to mobile robots, locomotion, kinematics of different mechanism, kinematics models of sensors actuators. Uncertainty in mobile robot motion and how to deal with it (Kalman filters, Particle Filters Monte Carlo Techniques). Control of mobile robots including obstacle avoidance, path and trajectory following. Robot perception, including algorithms for perception, sensors, visual tracking and servoing. Robot mapping and localization including SLAM. Motion planning for non holomic and holonomic robots (sampling based algorithms, bug algorithms), real time planning and dynamic environments. Robot control architectures and embedded electronics.

Recommended Books

1. Principles of Robot Motion: Theory, Algorithms, and Implementations by Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki, and Sebastian Thrun, Latest Edition
2. The Robotics Primer by Maja J Mataric, Latest Edition
3. Mobile Robotics: Mathematics, Models, and Methods by Alonzo Kelly, Latest Edition
4. Introduction to Autonomous Mobile Robots, By Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, Latest Edition
5. Probabilistic robotics by Sebastian Thrun , Wolfram Burgard ,Dieter Fox, Latest Edition

MTE-3xx COMPUTER AIDED ENGINEERING

Course Objectives

To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software's. To impart knowledge on the use of Finite Element Analysis software to solve various field problems in engineering to optimize and verify the design of machine elements. To cover machining theory, automated CNC machining, and process control.

Topics Covered

CAD/CAM Theory: Introduction to CAD/CAM, geometric modeling, computer graphics, product design and development, product manufacturing and management and CAD/CAM programming and CNC machining.

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc., Exercises shall include analysis of i) Machine elements under Static loads ii) Thermal Analysis of mechanical systems iii) Modal Analysis iv) Machine elements under Dynamic loads v) Non-linear systems

Recommended Books

1. Mastering CAD/CAM by Zeid, McGraw-Hill, Inc, 2005.
2. CAD/CAM by Taylor, Addison Wesley
3. Understanding CAD/CAM by Bowman, Howard Co
4. ANSYS Manuals, ANSYS Publications

MTE-4xx ARTIFICIAL INTELLIGENCE

Course Objectives

To educate the students of BE Mechatronics about Artificial Intelligence (AI), technologies needed for implementing AI, and the logic used in various AI applications like Computer Vision, Robotics, Expert Systems, Natural Language Processing etc.

Topics Covered

Introduction of AI. Intelligent agents, Overview of areas of application of AI and the technologies needed for AI. Expert systems development life cycle. Major parts of an Expert System. Expert System Shells. Knowledge Representation Techniques; First Order Logic, Predicate Logic, Temporal Logic, Production Rules, Semantic nets, Frames. Programming examples of Prolog. Constraint Satisfaction Problem. Searches; Uninformed and informed searches. Miscellaneous applications of AI in Mechatronics. Robotics, path planning using AI algorithms like A* algorithm, Game Playing / Problem Solving. Introduction to Learning Algorithms; Neural Networks.

Recommended Books

1. Peter Norvig and Stuart J. Russell, "Artificial Intelligence: A Modern Approach", Prentice Hall, 3rd Ed.
2. Mishkoff, H C. "Understanding Artificial Intelligence", Sams Understanding Series, Howard W. Sams& Co Inc., USA, 2000.
3. Charniak, E & Mcdermott, D. "Introduction to Artificial Intelligence", Addison-Wesley Longman Inc., USA, 2nd ed.1999.
4. Rafael Gonzalez and Richard Woods "Digital Signal Processing", Prentice Hall, ISBN: 0201180758, 2nd edition, 2002.

MTE-4xx MACHINE VISION

Course Objective

To equip the students with advanced vision systems for interactive systems using advanced image processing techniques.

Course Contents

Introduction to machine vision, image processing tools and techniques, Hough Transform, Morphological operators, Edge detection, Image Segmentation, 3D vision, Shape description and modelling, Geometry of projection and co-ordinate transformations, Surface reconstruction, Recognizing and tracking objects, Recognizing activities and events, Image registration, Texture analysis, Applications of machine vision.

Recommended Books

1. Image Processing, Analysis, and Machine Vision by Milan Sonka, Vaclav Hlavac and Roger Boyle, 2014
2. Digital Image Processing Using Matlab by Rafael C. Gonzalez and Richard E. Woods, Pearson Education, 2004

MTE-3xx INTRODUCTION TO SYSTEM ENGINEERING

Course Objectives

This course provides an introduction to the processes and methods that are used by systems engineering teams in order to achieve a successful outcome on complex systems projects from their conception through to ultimate disposal. The course also explores the management challenges of systems engineering, considering the business context within which projects are undertaken. The methods covered are applicable to the management of complex engineering projects in a wide range of sectors such as aircraft, space, rail, automotive, marine, defense, information technology and civil engineering.

Topics Covered

- Introduction to Systems, Systems Engineering
- Common Problems in Systems Projects
- Requirements, designing the system and sub-system development
- Systems Engineering Lifecycles and Processes
- Integration, verification and validation
- Support and disposal
- Managing design integrity
- Systems engineering management
- Organising for Effective Systems Engineering
- Understanding and Dealing with Systems
- Achieving a Successful Systems Engineering Approach.

Recommended Books

1. Systems Engineering Practice by R.I. Faulcon bridge and M.J. Ryan, Latest Ed
2. 1R.I. Faulconbridge and M.J. Ryan,"Systems Engineering Practice"
2. *INCOSE Systems Engineering Handbook, v3.*

MTE-3xx COMPUTER INTEGRATED MANUFACTURING

Course Objectives

The objective of this course is to develop an understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques. İt also develops an

understanding of computer-integrated manufacturing (CIM) and its impact on productivity, product cost, and quality.
This course helps to obtain an overview of computer technologies including computers, database and data collection, machine control, etc., as they apply to factory management and factory floor operations. It also describes the integration of manufacturing activities into a complete system and helps to enhance performance of manufacturing systems by applying different CIM concepts and tools.

Topics Covered
Introduction to Computer Integrated Manufacturing, Importance of CIM, Business Perspectives for CIM, Business Characteristics of CIM systems, Justifying Investments, Human Resource Requirements, Quality Issues, Implementation Difficulties / Analysis of Manufacturing Operations, Computers in Manufacturing, Peripherals, Factory Information Systems (FIS), Group Technology/ Coding systems, Cellular Manufacturing, Facility Layout, Flexible Manufacturing Systems (FMS), Product Design, Computer Aided Process Planning (CAPP).

Recommended Books

1. Principles of Computer Integrated Manufacturing by S Kant Vajpayee, 1995 Prentice Hall India. Reprinted in 2006
2. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P. Groover, Prentice Hall, 3rd Edition or latest (2007)
3. Computer Integrated Manufacturing, from fundamentals to implementation by Alan Weatherall
4. Principles of Automation and Advanced Manufacturing Systems, by K C Jain & Sanjay Jain, Khanna Publishers. First Edition 2004
5. Selected papers from research publications

ANNEXURE - A

English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents

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

Comprehension
Answers to questions on a given text

Discussion
General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Listening
To be improved by showing documentaries/films carefully selected by subject teachers

Translation skills

Urdu to English

Paragraph writing
Topics to be chosen at the discretion of the teacher

Presentation skills
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.

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

English II (Communication Skills)

Objectives: 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, minutes of meetings, use of library and internet

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).

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
3. Study Skills by Richard York.

English III (Technical Writing and Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents

Presentation skills

Essay writing

Descriptive, narrative, discursive, argumentative

Academic writing

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

Technical Report writing

Progress report writing

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. McGraw-Hill Higher Education. 2004.
   3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

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

ANNEXURE - B

Pakistan Studies (Compulsory)

Introduction/Objectives

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

Course Outline

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 Bangladesh,* 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: Wm Dawson & 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.

ANNEXURE - C

ISLAMIC STUDIES
(Compulsory)

Objectives

This course is aimed at:

1 To provide Basic information about Islamic Studies
2 To enhance understanding of the students regarding Islamic Civilization
3 To improve Students skill to perform prayers and other worships
4 To enhance the skill of the students for understanding of issues related to faith and religious life.

Detail of Courses

Introduction to Quranic Studies

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

Study of Selected Text of Holly Quran

1. Verses of Surah Al-Baqara 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 (Verse No-1-11)
4. Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
5. Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

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 (Verse No-1,14)

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

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

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

Selected Study from Text of Hadith

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

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

Islam & Science

1. Basic Concepts of Islam & Science
2. Contributions of Muslims in the Development of Science
3. Quran & Science

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

Political System of Islam

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

Islamic History

1. Period of Khlaft-E-Rashida
2. Period of Ummayyads
3. Period of Abbasids

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 Jurisprudence 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)

ANNEXURE - D

Note: One course will be selected from the following six courses of Mathematics.

COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

(FOR STUDENTS NOT MAJORING IN MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level

Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

Course Outline:
Preliminaries: Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

Quadratic Equations: Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

Sequences and Series: Arithmetic progression, geometric progression, harmonic progression. *Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

Recommended Books

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)
2. Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

2. MATHEMATICS II (CALCULUS)

Prerequisite(s): Mathematics I (Algebra)
Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline

Preliminaries: Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities. *Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

Derivatives and their Applications: Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.
Integration and Definite Integrals: Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

Recommended Books

1. Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8th edition), 2005, John Wiley, New York
2. Stewart J, *Calculus* (3rd edition), 1995, Brooks/Cole (suggested text)
3. Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston
4. Thomas GB, Finney AR, *Calculus* (11th edition), 2005, Addison-Wesley, Reading, Ma, USA

3. MATHEMATICS III (GEOMETRY)

Prerequisite(s): Mathematics II (Calculus)
Credit Hours: 3 + 0

Specific Objectives of the Course: To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

Course Outline
Geometry in Two Dimensions: Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

Circle: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.
Conic Sections: Parabola, ellipse, hyperbola, the general-second-degree equation

Recommended Books

1. Abraham S, Analytic Geometry, Scott, Freshman and Company, 1969
2. Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston
3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

Title of subject:		MATHEMATICS
Discipline	:	BS (Social Sciences).
Pre-requisites	:	SSC (Metric) level Mathematics
Credit Hours	:	03 + 00
Minimum Contact Hours:		40
Assessment	:	written examination;
Effective	:	2008 and onward

Aims : To give the basic knowledge of Mathematics and prepare the students not majoring in mathematics.

Objectives : After completion of this course the student should be able to:

- Understand the use of the essential tools of basic mathematics;
- Apply the concepts and the techniques in their respective disciplines;
- Model the effects non-isothermal problems through different domains;

Contents :

1. *Algebra*

Preliminaries: Real and complex numbers, Introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. *Quadratic equations:* Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. *Sequence and Series:* Arithmetic, geometric and harmonic progressions. *Permutation and combinations*: Introduction to permutation and combinations, *Binomial Theorem:* Introduction to binomial theorem.

Trigonometry: Fundamentals of trigonometry, trigonometric identities. *Graphs:* Graph of straight line, circle and trigonometric functions.

2. *Statistics*

Introduction: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution*: Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. *Measures of central tendency*: Mean medium and modes, quartiles, deciles and percentiles. *Measures of dispersion*: Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

Recommended Books

1. Swokowski. E. W., '*Fundamentals of Algebra and Trigonometry*', Latest Edition.
2. Kaufmann. J. E., '*College Algebra and Trigonometry*', PWS-Kent Company, Boston, Latest Edition.
3. Walpole, R. E., '*Introduction of Statistics*', Prentice Hall, Latest Edition.
4. Wilcox, R. R., '*Statistics for The Social Sciences'*,

5. MATHEMATICS FOR CHEMISTRY

Credit Hours: 3

Prerequisites: Mathematics at Secondary level

Specific Objectives of Course:

To prepare the students not majoring in mathematics with the essential tools of Calculus to apply the concepts and the techniques in their respective disciplines.

Course Outline

Preliminaries: Real Numbers and the Real Line, *Functions and their graphs*: Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. *Limits and Continuity:* Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. *Derivatives and its Applications:* Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions. *Integration and Indefinite Integrals:*

Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

Recommended Books

1. Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, John Willey & Sons, Inc. 2005.
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelsohn, Calculus, Schaum's Outline Series, 4th edition, 1999.
5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.
6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

6. MATHEMATICS FOR PHYSICS

Contents

1. Preliminary calculus.

- Differentiation
  Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz' theorem; special points of a function; theorems of differentiation.
- Integration
  Integration from first principles; the inverse of differentiation; integration by inspection; sinusoidal function; logarithmic integration; integration using partial fractions; substitution method; integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration.

2. Complex numbers and hyperbolic functions

- The need for complex numbers
- Manipulation of complex numbers
  Additions and subtraction; modulus and argument; multiplication; complex conjugate; division
- Polar representation of complex numbers Multiplication and division in polar form
- de Moivre's theorem
  Trigonometrical identities; finding the nth roots of unity; solving polynomial equations
- Complex logarithms and complex powers

- Applications to differentiation and integration
- Hyperbolic functions
  Definitions; hyperbolic-trigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions; calculus of hyperbolic functions

3. Series and limits

- Series
- Summation of series
  Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series
- Convergence of infinite series
  Absolute and conditional convergence; convergence of a series containing only real positive terms; alternating series test
- Operations with series
- Power series
  Convergence of power series; operations with power series
- Taylor series
  Taylor's theorem; approximation errors in Taylor series; standard McLaurin series
- Evaluation of limits

4. Partial differentiation

- Definition of the partial derivative
- The total differential and total derivative
- Exact and inexact differentials
- Useful theorems of partial differentiation
- The chain rule
- Change of variables
- Taylor's theorem for many-variable functions
- Stationary values of many-variable functions
- Stationary values under constraints

5. Multiple integrals

- Double integrals
- Triple integrals
- Applications of multiple integrals
  Areas and volumes; masses, centers of mass and centroids; Pappus' theorems; moments of inertia; mean values of functions
- Change of variables in multiple integrals
  Change of variables in double integrals;

6. Vector algebra

- Scalars and vectors

- Addition and subtraction of vectors
- Multiplication by a scalar
- Basis vectors and components
- Magnitude of a vectors
- Multiplication of vectors
  Scalar product; vector product; scalar triple product; vector triple product
- Equations of lines and planes
  Equation of a line; equation of a plane
- Using vectors to find distances
  Point to line; point to plane; line to line; line to plane
- Reciprocal vectors

7. Matrices and vector spaces

- Vectors spaces Basic vectors; the inner product; some useful inequalities
- Matrices
- The complex and Hermitian conjugates of a matrix
- The determinant of a matrix
  Properties of determinants
- The inverse of a matrix
- The rank of a matrix
- Simultaneous linear equations
  N simultaneous linear equations in N unknowns
- Special square matrices
  Diagonal; symmetric and antisymmetric; orthogonal; Hermitian; unitary normal
- Eigen vectors and eigen values
  Of a normal matrix; of Hermitian and anti-Hermitian matrices; of a unitary matrix; of a general square matrix
- Determination of eigen values and eigen vectors Degenerate eigen values

8. Vector calculus

- Differentiation of vectors Composite vector expressions; differential of a vector
- Integration of vectors
- Space curves
- Vector functions of several arguments
- Surfaces
- Scalar and vector fields
- Vector operators
- Gradient of a scalar field; divergence of a vector field; curl of a vector field
- Vector operator formulae

- Vector operators acting on sums and products; combinations of grad, div and curl
- Cylindrical and spherical polar coordinates
- Cylindrical polar coordinates; spherical polar coordinates.

ANNEXURE - E

Statistics-I **Credit 3 (2-1)**

Definition and importance of Statistics in Agriculture, Data Different types of data and variables

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf diagram, Graphical representation of data Histogram, frequency polygon, frequency curve.

Measure of Central tendency, Definition and calculation of Arithmetic mean, Geometric mean, Harmonic mean, Median quantiles and Mode in grouped and un-grouped data.

Measure of Dispersion, Definition and Calculation of Range, quartile deviation, Mean deviation, Standard deviation and variance, coefficient of variation.

Practical

a. Frequency Distribution
b. Stem-and-Leaf diagram
c. Various types of Graphs
d. Mean, Geometric mean Harmonic Mean,
e. Median, Quartiles Deviation, mean Deviation.
f. Standard Deviation, Variance, Coefficient of variation,
g. Skewness and kenosis

Recommended Books

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. A. Concise Course in A. Level Statistic with world examples by J. Crashaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 2nd Ed. (1986) Fran II. Dietrich-II and Thomas J. Keans

Statistics-II **Credit 3 (2-1)**

Sampling Probability and non-Probability Sampling, Simple random sampling stratified random sampling Systematic sampling error, Sampling distribution of mean and difference between two means. Interference Theory: Estimation and testing of hypothesis, Type—I and type-II error, Testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test, Test of association of attributes using X2 (chi-square) Testing hypothesis about variance.

Practical

a. Sampling random sampling
b. Stratified random sampling.
c. Sampling distribution of mean
d. Testing of hypotheses regarding population mean
e. Testing of hypotheses about the difference between population means
f. Chi-square test
g. Testing of Correlation Coefficient
h. Fitting of simple linear regression
i. One-way ANOVA
j. Two-way ANOVA

Recommended Books

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. Principles and Procedures of Statistics A Bio-material approach, 2nd Edition, 1980 by R. G. D Steal and James H. Tarric
4. Statistical Procedures for Agricultural Research 2nd Edition (1980) by K. A. Gomez and A. A. Gomez

ANNEXURE - F

Introduction to Information and Communication Technologies

Course Structure:	Lectures: 2 Labs: 1	**Credit Hours:** 3
Pre-requisite:	**None**	**Semester: 1**

Course Description

This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and World Wide Web, and ICT based applications.

After completing this course, a student will be able to:

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT

Course Contents

Basic Definitions & Concepts
Hardware: Computer Systems & Components
Storage Devices, Number Systems
Software: Operating Systems, Programming and Application Software
Introduction to Programming, Databases and Information Systems
Networks
Data Communication
The Internet, Browsers and Search Engines
The Internet: Email, Collaborative Computing and Social Networking
The Internet: E-Commerce
IT Security and other issues
Project Week
Review Week

Text Books/Reference Books

1. Introduction to Computers by Peter Norton, 6th International Edition, McGraw-Hill
2. Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6th Edition, McGraw-Hill
3. Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Swayer
4. Fundamentals of Information Technology by Alexis Leon, Mathews Leon, Leon Press.

Recommendations

- This curriculum may be used as a guideline by the universities and institutions in Pakistan to develop their curriculum in order to have uniform standard education in their programmes.
- The NCRC used HEC curriculum template as the standard working document for BE/BS/BSc mechatronics curriculum. The curriculum is divided into engineering and non-engineering domain. Engineering courses are proposed to make up to 65-70% of total curriculum, whereas, the non-engineering courses cover 30-35% the curriculum Engineering domain of the curriculum is further divided into computing, foundation, breadth (Core), and depth (Core).
- The committee recommended addition of new courses to the revised curriculum. These courses are Social Science Elective II. Electrical Network Analysis, Fundamentals of thermal Sciences, Engineering Elective III, Signals and Systems, Modeling and Simulation and Solid Modeling. In addition to this, Power Electronics and Industrial Automation are included in the revised curriculum as elective courses.
- The committee decided that health and safety education is to be made mandatory through 1-2 days seminar/workshop for faculty, staff and students.
- The committee proposed the formation of Mechatronics Engineering Society of Pakistan to strengthen the Mechatronics Engineering activities. It was decided that an International Conference will be held annually or biennially and will be rotated within different universities of the country.
- It is recommended that Mechatronics engineering faculty members should have a MS/PhD with background in Mechatronics, Control Systems, Mechanical, Electrical/ Electronics, Robotics, Systems Engineering, Automation, Industrial Engineering or experience in academia or industry in Mechatronics systems.
- The curriculum of MS/MSc/ME programme is revised and approved.