CURRICULUM

OF

MECHANICAL ENGINEERING

BS/BE
MS/ME

(Revised 2012)

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

Prof. Dr. Syed Sohail H. Naqvi	Executive Director
Mr. Muhammad Javed Khan	Adviser (Academics)
Malik Arshad Mahmood	Director (Curri)
Dr. M. Tahir Ali Shah	Deputy Director (Curri)
Mr. Farrukh Raza	Asst. Director (Curri)
Mr. Abdul Fatah Bhatti	Asst. Director (Curri)

Composed by: Mr. Zulfiqar Ali, HEC, Islamabad

CONTENTS

PREFACE

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

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

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

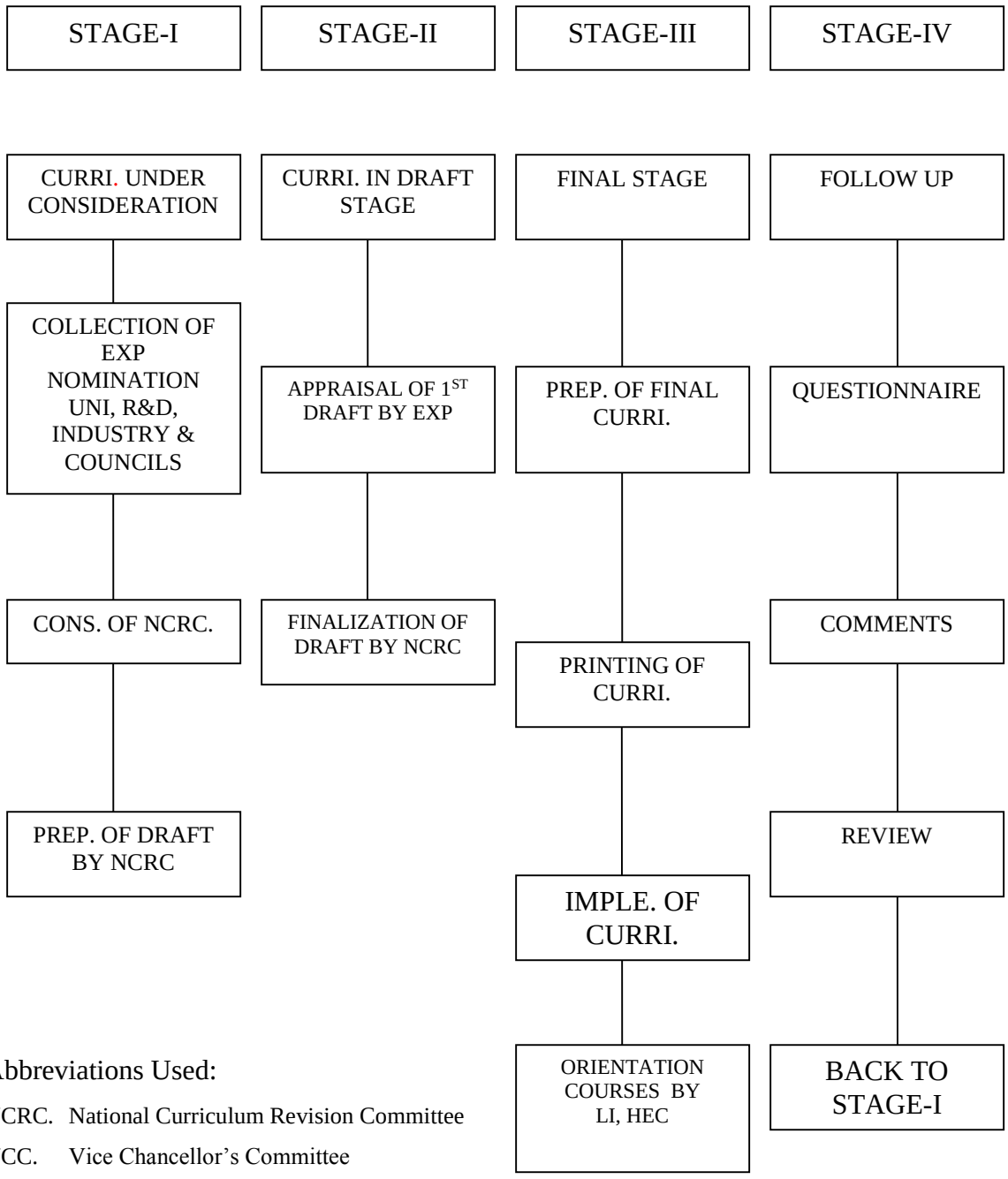
To bring international compatibility to qualifications held from Pakistani universities/DAIs for promotion of student's mobility and job seekers around the globe, a Committee comprising of Conveners of the National Curriculum Revision Committee of HEC met in 2009 and developed a unified template for standardized 4-years/8-semesters BS degree programmes. This unified template was aimed to inculcate broader base of knowledge in the subjects like English, Sociology, Philosophy, Economics etc. in addition to major discipline of study. The Bachelor (BS) degree course requires to be completed in 4-years/8-semesters, and shall require qualifying of 130-140 credit hours of which 65 to 70% of the curriculum will constitute discipline specific and remaining 30 to 35% will comprise compulsory and general courses.

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

MUHAMMAD JAVED KHAN
Adviser (Academics)

April, 2012

CURRICULUM DEVELOPMENT PROCESS



Abbreviations Used:

NCRC. National Curriculum Revision Committee

VCC. Vice Chancellor's Committee

EXP. Experts

COL. Colleges

UNI. Universities

PREP. Preparation

REC. Recommendations

LI Learning Innovation

R&D Research & Development Organization

HEC Higher Education Commission

INTRODUCTION

Final NCRC Meeting in mechanical Engineering held on March 5-7, 2012 at HEC Regional Centre, Karachi. Following attended the meeting:

Sr.	Name	
1.	Dr. Ejaz M. Shahid Associate Professor, Department of Mechanical Engineering, University of Engineering Technology, Lahore.	Convener
2.	Dr. Hamid Ullah Professor, Department of Mechanical Engineering, University of Engineering & Technology, Peshawar.	Secretary
3.	Dr. Muhammad Sajid Assistant Professor, Department of Mechanical Engineering, SMME, NUST, Sector H-12, Islamabad.	Member
4.	Dr. Muhammad Aurangzeb Khan Manager (Mechanical), Project Management Organization, Expert Engineering, Opposite EME College, Peshawar Road, Rawalpindi.	Member
5.	Dr. S. Kamran Afaq Professor/ Chairman, Department of Mechanical Engineering, Hitec University Secretariat, Taxila Cantt.	Member
6.	Dr. Mubashir Ali Siddiqui Professor, Department of Mechanical Engineering, NED University of Engineering & Technology, Karachi.	Member
7.	Dr. Fraz Junejo Assistant Professor / HOD, Department of Mechatronics, Shaheed Zulfikar Ali Bhutto Institute of Science and Technology (SZABIST), 90 Clifton, Karachi.	Member

8.	Dr. Ali Faraz Member Manager P&M Division, Pakistani Space & Upper Atmosphere Research Commission (SUPARCO), SUPARCO HQs, PO Box 8402, Karachi - 75270.
9.	Engr. Fayza Naz Member Manager, Pakistan Institute of Nuclear Science & Technology, (PINSTECH), Nilore, Islamabad.
10.	Dr. Abdul Sattar Jamali Member Professor, Department of Mechanical Engineering, Quaid-e-Awam University of Engg, Science & Technology (QUEST), Nawabshah.
11.	Prof. Dr. Javed Ahmad Chattha Member Professor/Dean Faculty of Mechanical Engineering, Ghulam Ishaq Khan (GIK) Institute, Topi 23640, KPK.
12.	Engr. Bashir Ahmed Laghari Member Assistant Professor, Department of Mechanical Engineering, Baluchistan University of Engineering & Technology (BUET), Khuzdar.
13.	Prof. Dr. Hassan Ali Durani Member Department of Mechanical Engineering, Mehran University of Engineering and Technology, Jamshoro.
14.	Prof. Dr. Nasiruddin Shaikh Member NED University of Engineering & Technology, University Road, Karachi.
15.	Prof. Dr. Younis Jamil Member Department of Mechanical Engineering, University of Engineering Technology, Lahore.

FRAMEWORK/TEMPLATE

BS/BE/BSc ENGINEERING PROGRAMME IN MECHANICAL ENGINEERING

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: 130-136
Engineering Course (Minimum) 70 per cent
Non-Engineering Course (Maximum) 30 per cent

Non-Engineering Domain									
Knowledge Area	**Subject Area**	**Name of Course**	**Lec CH**	**Lab CH**	**CR**	**Total Courses**	**Total Credits**	**% Area**	**% overall**
Humanities	English	English-I	3	0	3	3	8	20	5.88
		English-II	2	0	2				
		English-III	3	0	3				
	Culture	Pakistan Studies	2	0	2	2	4	10	2.94
		Islamic Studies/ Ethics	2	0	2				
	Social Sciences	Social Science	2	0	2	1	2	5	1.47
Management sciences		Management Elective-1	3	0	3	2	5	12.5	3.68
		Engineering Management and Economics	2	0	2				
Natural Sciences	Physics	Physics	2	1	3	1	3	7.5	2.21
	Mathema-tics	Mathematics-1	3	0	3	4	12	30	8.82
		Mathematics-2	3	0	3				
		Mathematics-3	3	0	3				
		Mathematics-4	3	0	3				
	Electives	Chemistry	2	1	3	2	6	15	4.41
		Mathematics-5	3	0	3				
TOTAL						**15**	**40**	**100**	**29.41**

Engineering Domain									
Knowledge Area	**Subject Area**	**Name of Course**	**Lec CH**	**Lab CH**	**CR**	**Total Courses**	**Total Credits**	**% Area**	**% overall**
Computing	Fundamentals	Computers Systems and Programming	2	1	3	1	3	3.13	2.21
Engineering Foundation		Engineering Drawing and Graphics	2	1	3	11	35	36.46	25.74
		Engineering Mechanics-I: Statics	3	0	3				
		Engineering Mechanics-II: Dynamics	3	1	4				
		Mechanics of Materials-I	3	0	3				
		Thermodynamics-I	3	0	3				
		Workshop Practice	0	2	2				
		Mechanics of Machines	3	1	4				
		Fluid Mechanics-I	3	0	3				
		Manufacturing Processes	3	1	4				
		Precision Engineering and Metrology	2	1	3				
		Engineering Materials	3	0	3				
Major Based Core (Breadth)		Machine Design and CAD-I	2	1	3	7	26	27.08	19.12
		Machine Design and CAD-II	3	1	4				
		Fluid Mechanics-II	3	1	4				
		Heat and Mass Transfer	3	1	4				
		Control Engineering	2	1	3				
		Thermodynamics-II	3	1	4				
		Mechanics of Materials-II	3	1	4				
Major Based Core (Depth)		Internal Combustion Engines	2	1	3	6	20	20.83	14.70
		Mechanical Vibrations	3	1	4				
		Refrigeration and Air Conditioning	3	1	4				
		Technical Elective-I	3	0	3				
		Technical Elective-II	3	0	3				
		Technical Elective-III	3	0	3				
Inter-disciplinary		Electrical Engineering	2	1	3	2	6	6.25	4.41

Engineering Breadth (Electives)		Electronics Engineering	2	1	3				
Senior Design Project		Project	0	3	3	2	6	6.25	4.41
		Project	0	3	3				
Industrial Training			0	0	0	0	0	0	0
TOTAL						**29**	**96**	**100**	**70.59**
Grand Total						**44**	**136**		**100**

DETAIL OF COURSES

NON-ENGINEERING DOMAIN

COURSES FOR HUMANITIES

COMPREHENSION AND COMPOSITION 3+0

Knowledge Area / Sub Area: Humanities / English – I

Specific Objective:
To enhance language skills and develop critical thinking

Course Outline:
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, 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:
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

COMMUNICATION SKILLS 3+0

Knowledge Area / Sub Area: Humanities / English – II

Specific Objective:

To enable the students to meet their real life communication needs

Course Outline:

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

Essay writing: Introduction

CV and job application

Translation skills: Urdu to English

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

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

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

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

Recommended Books:

a) Grammar

1. A. J. Thomson and A. V. Martinet, *Practical English Grammar*. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing

1. Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet, *Writing. Intermediate*. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
2. Rob Nolasco, *Writing. Upper-Intermediate*. 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. Brian Tomlinson and Rod Ellis, *Reading. Advanced*. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.

2. John Langan, *Reading and Study Skills*
3. Riachard Yorky, *Study Skills*

REPORT WRITING SKILLS 2+0

Knowledge Area / Sub Area: Humanities / English – III

Specific Objective:
To enhance language skills and develop critical thinking

Course Outline:

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:
a) Essay Writing and Academic Writing
   1. Ron White, *Writing. Advanced*. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
   2. John Langan, *College Writing Skills*. McGraw-Hill Higher Education. 2004.
   3. Laurie G. Kirszner and Stephen R. Mandell, *Patterns of College Writing* (4th edition) by. St. Martin's Press.

b) Reading
   1. Janice Neulib et al. (Editors), *The Mercury Reader. A Custom Publication*. Compiled by Northern Illinois University. General Editors: (A reading which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

PAKISTAN STUDIES (Compulsory) 2+0

Knowledge Area / Sub Area: Humanities / Culture

Specific Objectives:

i To develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan and

ii To 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, t*he 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: WmDawson & Sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh.* Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan,* Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan.* Boston: Houghton Mifflin, 1967.
12. Aziz, K. K. *Party, Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, Pakistan under Martial Law, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective.* Islamabad: National Commission on Historical and Cultural Research, 1993.

ISLAMIC STUDIES 2+0

Knowledge Area / Sub Area: N/A

Specific 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**.**

Course Outline:

INTRODUCTION TO QURANIC STUDIES

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

STUDY OF SELLECTED TEXT OF HOLLY QURAN

1) Verses of Surah Al-Baqra Related to Faith (Verse No. 284-286)
2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (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 SELLECTED 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 (Verse No. 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

SELLECTED STUDY FROM TEXT OF HADITH

INTRODUCTION TO ISLAMIC LAW AND 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

Recommended Books:

1) Hameed ullah Muhammad, "**Emergence of Islam**" , IRI, Islamabad
2) Hameed ullah Muhammad, "**Muslim Conduct of State**"
3) Hameed ullah Muhammad, '**Introduction to Islam**
4) Mulana Muhammad Yousaf Islahi,"
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)

SOCIAL SCIENCES COURSES

(Any two courses of the following)

SOCIOLOGY AND DEVELOPMENT 3+0

Knowledge Area / Sub Area: Social Science

Specific Objectives:

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

Course Outline:

1. Introduction to Sociology

1.1 What is sociology?
1.2 Nature, Scope, and Importance of Sociology

1.3 Social Interactions
1.4 Social Groups
1.5 Social Institutions

2. Culture and Related Concepts

2.1 Definition of Culture
2.2 Types of Culture
2.3 Elements of Culture
2.4 Role of Culture in Organization
2.5 Socialization and Personality

3. Interpersonal Relations

3.1 Interpersonal Behaviour
3.2 Formation of Personal Attitudes
3.3 Language and Communication
3.4 Motivations and Emotions
3.5 Public Opinion

4. Social Stratification

4.1 Factors of Social Stratification
4.2 Caste and class
4.3 Power, Prestige, and Authority
4.4 Social Mobility
4.5 Migration

5. Human Ecology

5.1 Ecological Processes
5.2 Ecosystem and energy
5.3 Ecosystem and Physical Environment
5.4 Solid Waste Disposal
5.5 Pollution

6. Population Dynamics

6.1 World Population Growth and Distribution
6.2 Population Dynamics in Pakistan
6.3 Causes and Consequences of Urbanization
6.4 Population Policy in Pakistan
6.5 Population and Development

7. Community Development

7.1 Meaning, Scope, and Subject Matter of Community Development
7.2 Processes of Community Development
7.3 Community Development Programs in Pakistan
7.4 Community Organization and Related Services
7.5 Cooperation and Conflict in Community Development

8. Deviance and Crime

8.1 Crime as a Social and Cultural Phenomenon
8.2 Crime and Social Organization
8.3 Organized Crime
8.4 Culture Based Crime
8.5 Economics of Crime

9. Sociology of Change and Development

9.1 What is Social Change and Development?
9.2 Dynamics of Social Change
9.3 Role of NGOs in Development
9.4 World System and Development
9.5 Gender and Development

Recommended Books:

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

SOCIAL ANTHROPOLOGY 3+0

Knowledge Area / Sub Area: Social Science

Specific Objectives:

The students are expected to learn anthropological skills for application by professional engineers and other related practitioners. Societal growth needs are

to be understood within our own cultural environment. Such a body of applied knowledge will result in improving the professional performance of would-be engineers. As culture and society play an important role towards all human activities, this course will help students relate technical skills to the societal needs and requirements.

Course Outline:

I Introduction

1. Anthropology and Social Anthropology
2. Fields of Anthropology
3. Anthropological Research Methods
4. Social Anthropology and other Social Sciences
5. Significance of Social Anthropology

II Culture

1. Definition, Properties and Taxonomy
2. Evolution of Growth and Culture
3. Evolution of Man: Religious and Modern Perspectives
4. Evolution of Culture
5. Culture and Personality

III Evolution and Growth of Culture

1. Evolution of Man
2. Schools of Thought in Cultural Anthropology
3. Acculturation
4. Enculturation
5. Ethnocentrism and Xenocentrism

IV Language and Culture

1. Communication
2. Structural Linguistics
3. Historical Linguistics
4. Relationship between Language and Culture
5. Ethnography

V Economic System

1. Global Economic System
2. The Allocation of Resources
3. The Conversion of Resources
4. The Distribution of Goods and Services
5. Poverty and Inequality

VI Marriage and Family

1. Marriage and Mate Selection
2. The Family: Types and Functions
3. Kinship System
4. Structure and Function of Family

5. Gender Relations

VII Political Organization

1. Political Sociology
2. Origin of Political Organization and Organizational System
3. Types of Political Organizations
4. Power Politics and Factionalism in Pakistan
5. Resolution of Conflict

VIII Religion and Magic

1. The Universality of Religion
2. Comparative Religions
3. Religion and Society
4. Religious Beliefs and Practices
5. Witchcraft and Sorcery

IX Culture Change

1. Forms of Art
2. Expressive Culture
3. Process of Cultural Change
4. Cultural Change in the Modern World
5. Cultural Change in Pakistani society

Recommended Books:

1. Ahmad, Akbar S. 1990. Pakistani Society, Karachi, Royal Books Co.
2. Bernard, H. Russel. 1994. Research Methods in Anthropology, Qualitative and Quantitative Approaches. London: Sage Publications
3. Bodley, John H. 1994. Cultural Anthropology, California: Mayfield Publishing Co.
4. Brogger, Jan. 1993. Social Anthropology and the Lonely Crowd. New Delhi: Reliance Publishing
5. Ember, Carol R. & Ember Melvin. 2005. Anthropology, 11th ed. Englewood Cliffs: Prentice Hall, Ince. Harper and Row
6. Harris Marvin. 1987. Cultural Anthropology. New York: Harper and Row
7. Harris Marvin. 1985. Culture, People, nature; An Introduction to General Anthropology London: Harper and Row
8. Haviland, W. A. (2005). Anthropology: The Human Challenge. New York, Thomson Learning Inc.
9. Hertzler J. O. 1981. The Social Structure of Islam. Cambridge: Cambridge University Press.
10. Keesing, Roger m. 1998. Cultural Anthropology: A contemporary perspective. 3rd ed. New York: Harcourt Brace College Publishers.
11. Kottak, Conard Phillip. 2002. Anthropology: The Exploration of Human Diversity. 9th ed. Boston: McGraw-Hill Higher Education.
12. Kennedy, Charles H. 1992. Pakistan London: Westview Press.
13. Marron, Stanley. 1057. Pakistani Society and Culture. New Heaven

14. Wilson, Richard A. 1996. Human Rights, Culture and Context: Anthropological Perspective. London: Pluto Press.

UNDERSTANDING PSYCHOLOGY AND HUMAN BEHAVIOUR 3+0

Knowledge Area / Sub Area: Social Science

Specific Objectives:

- To give introduction to Psychology
- To give basic understanding of human behaviour

Course Outline:

- What is Psychology?
- Nature, Scope and Application with Special Reference to Pakistan
- Different Schools of Psychology
- Methods of Psychology
- Learning
- Intelligence and Artificial Intelligence
- Personality and its Assessment
- Understanding Maladjustive Behaviour
- Positive Emotional States and Processes
- Stress Management and Anger Management

Recommended Books:

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

PROFESSIONAL PSYCHOLOGY 3+0

Knowledge Area / Sub Area: Social Science

Specific Objective:
To give understanding of different branches / fields of professional psychology.

Course Outline:
- Introduction to Professional Psychology
- Psychological Testing
- Educational Psychology
- Industrial/Organizational Psychology
- Social Psychology
- Health Psychology
- Clinical Psychology
- Positive Psychology
- Legal, Ethical, and Professional Issues.

Recommended Books:

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

PROFESSIONAL ETHICS 3+0

Knowledge Area / Sub Area: Social Science

Specific Objectives:

This course introduce contemporary and controversial ethical issues facing the business community. Topics include moral reasoning, moral dilemmas, law and morality, equity, justice and fairness, ethical standards, and moral development. Upon completion, students should be able to demonstrate an understanding of their moral responsibilities and obligations as members of the workforce and society.

At the completion of the course requirements, the student will be able to:

a. Define business ethics
b. Describe the evolution of business ethics
c. Describe major ethical perspectives
d. Understand and apply n ethical decision-making framework
e. Understand social responsibility from several dimensions
f. Understand how the organization influences ethical decision-making
g. Examine how significant others influence ethical decision-making
h. Develop an effective ethics programme.
i. Understand international business ethics.

Course Outline:

An Overview of Business Ethics: Business Ethics Defined, Social Responsibility, and Business Ethics, The Development of Business Ethics, Why study Business Ethics?, Framework for Studying Business Ethics.

Ethical issues in Business: Foundation of Ethical Conflict, Classifications of Ethical, Issues, Ethical Issues Related to Participants and Functional Areas of Business, Recognizing an Ethical Issue.

Applying Moral Philosophies to Business Ethics: Moral Philosophy Defined, Moral Philosophy Perspectives.

Social Responsibility: The Economic Dimension, The legal Dimension, The Ethical Dimension, the Philanthropic Dimension.

An Ethical Decision-Making Framework: Ethical Issue Intensity, Individual Factors: Stages of Cognitive Moral Development, Corporate Culture, Significant others, Opportunity, Business Ethics Evaluations and Intentions, Using the Ethical Decision-Making Framework to Improve Ethical Decisions.

How the Organization Influences Ethical Decision Making: Organizational Structure and Business Ethics, the role of Corporate Culture in Ethical Decision-Making, Group Dimensions of Organizational Structure and Culture, Implications of Organizational Relationships for Ethical Decisions.

The Role of Opportunity and Conflict: Opportunity, Conflict.

Development of an Effective Ethics Programme: An Effective Ethical Compliance, Programme, Codes of Ethics and Compliance Standards, High-Level Manager's Responsibility for Ethical Compliance Programme and the Delegation of Authority, Effective Communication of Ethical Standards, Establishing Systems to Monitor, Audit, and Enforce Ethical Standards, Continuous Improvement of the Ethical Compliance Programme, The Influence of Personal Values in Business Ethics Programmes, The Ethical Compliance Audit.

International Business Ethics: Ethical Perceptions and International Business, Culture As a Factor in Business, Adapting Ethical Systems to a Global Framework: Cultural Relativism, the Multinational Corporation, A universal Set of Ethics, Ethical Issues Around the Globe.

Recommended Books:

1. Ferrell, O. C., and Fraedrich, John, Ethical Decision Making and Cases, New York: Houghton Mifflin.

ORGANIZATIONAL BEHAVIOUR 3+0

Knowledge Area / Sub Area: Social Science

Course Outline:

- Introduction to Organizational Behaviour
  - Organizational Disciplines and topics
  - Psychological Perspective
  - Social-Psychological Perspectives

- Structure and Control in Organization
  - Introduction
  - Bureaucracy
  - Managerial Work
  - Contingency theory
  - Organizational Design
- Individual and Work Learning
  - Learning Theories
  - Learning and Work
- Stress
  - Types of Stress and Work
  - Occupational Stress Management
- Individual Differences
  - Personality and its factors
  - Personality dimensions and social learning
  - Intelligence
- Motivation and Job Satisfaction
  - Needs at Work
  - Theories of Motivation and job satisfaction

    - Correlates of Job satisfaction
    - Correlates of Job satisfaction
- Group and Work
    - Social Interaction
    - Dramaturgy and impression Management
    - Social Skill
- Group and Inter-group Behaviour
    - Group Structure & Norms
    - Group Processes
    - How throne Studies
- Leadership
    - Leadership as an attribute
    - Leadership Style
- Patterns of Work
    - Work-the classical approach
    - Marx, Weber, & The critique of labour
    - Foucault & Disciplinary Power
- Conflict and Consent in Work
    - The labor Process debate
    - Work place control and resistance
    - Industrial conflict and industrial relations
- Organizational culture
    - Organizational culture and strategic management
    - Exploring organizational culture
    - Evaluating concept of culture

Recommended Books:

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

INTRODUCTION TO SOCIOLOGY 3+0

Knowledge Area / Sub Area: Social Science

Specific Objectives:

- To provide brief introduction of society
- To give understanding of different social institutions, culture, classes, stratification and social change.

Course Outline:

- The Nature of Sociology

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

    - Social and cultural change
- Social and cultural change
    - Definition of social change
    - Dynamics of social change
    - Impact of globalization on society and culture
    - Resistance to change
- Collective behaviour
    - Definition
    - Characteristics
    - Causes
    - Types
    - Social movements
    - Mob and crowd behaviour

Recommended Books:

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

CRITICAL THINKING 3+0

Knowledge Area / Sub Area: Social Science

Specific Objective:

To develop understanding of critical thinking.

Course Outline:

- The Power of Critical Thinking
    - Claims and Reasons
    - Reasons and Arguments
    - Arguments in the Rough
- The Environment of Critical Thinking
    - Perils of Haunted Mind
    - Self and the Power of the Group
    - Subjective and Social Relativism
    - Skepticism
- Making Sense of Arguments
    - Arguments Basics

    - Patterns
    - Diagramming Arguments
    - Assessing Long Arguments
- Reasons for Belief and Doubt
    - Conflict Experts and Evidence
    - Personal Experience
    - Fooling Ourselves
    - Claims in the News
- Faulty Reasoning
    - Irrelevant Premises
    - Genetic Fallacy, Composition, Division
    - Appeal to the Person, Equivocation, Appeal to Popularity
    - Appeal to Tradition, Appeal to Ignorance, Appeal to Emotion
    - Red Herring, Straw Man
- Unacceptable Premises
    - Begging the Question, False Dilemma
    - Slippery Slope, Hasty Generalization
    - Faulty Analogy
- Deductive Reasoning: Propositional Logic
    - Connectives and Truth Values
    - Conjunction, Disjunction, Negation
    - Conditional, Checking for Validity
    - Simple Arguments, Tricky Arguments
    - Streamlined Evaluation
- Deductive Reasoning: Categorical Logic
    - Statements and Classes
    - Translations and Standard Form
    - Terms, Quantifiers
    - Diagramming Categorical Statements
    - Sizing up Categorical Syllogisms
- Inductive Reasons
    - Enumerative Induction
    - Sample Size, Representativeness, Opinion Polls
    - Analogical Induction
    - Casual Arguments, Testing for Causes
    - Casual Confusions
- Inference to the Best Explanation
    - Explanations and Inference
    - Theories and Consistency
    - Theories and Criteria
    - Testability, Fruitfulness, Scope, Simplicity
    - Conservatism
- Judging Scientific Theories
    - Science and Not Science
    - The Scientific method, Testing Scientific Theories
    - Judging Scientific Theories
    - Copernicus versus Ptolemy, Evolution Versus Creationism

- Science and Weird Theories
- Making Weird Mistakes
- Leaping to the Weirdest Theory, Mixing What Seems with What is
- Misunderstanding the Possibilities
- Judging Weird Theories
- Crop Circles, Talking with the Dead

Recommended Books:

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

INTRODUCTION TO PHILOSOPHY 3+0

Knowledge Area / Sub Area: Social Science

Specific Objective:

To study the basic concepts of Philosophy

Course Outline:

- Definition and Nature of Philosophy
- Theory of Knowledge
  - Opinion and Knowledge
  - Plato, the Republic Selection
  - Knowledge through Reason
  - Descartes Meditation on First Philosophy
  - Knowledge through Experience
  - Hume an Inquiry concerning Human Understanding (Selection)
  - Experience Structured by the Mind
  - Kant Critique of Pure Reason (Selection
  - Knowing and Doing
  - James Pragmatism (Selection)
  - Knowledge and Emotion
  - Jaggar Love and Knowledge (Selection)
- Philosophy of Religion
  - Proving that Existence of God
  - Anselm, Aquinas, Paley, Dawkins (Selection)
  - Justifying Religious Beliefs
  - Pascal Pensees (Selection)
  - James The will to Believe Selection
  - Freud the Future of An Illusion (Selection)
  - Confronting the Problems of Evil
  - Mackie Evil and Omnipotence (Complete)
  - Hick Philosophy of Religion (Selection)
- Metaphysics

    - Idealism and Materialism
    - Berkeley Three Dialogues Between Hylas and Pholonous (Selection)
    - Armstrong Naturalism, Materialism and First Philosophy (Selection)
    - The Mid-Body Problem
    - Descartes Meditations on First Philosophy (Selection)
    - O'Hear Introduction to the Philosophy of Science (Selection)
    - Dennett The Origins of Selves (Complete)
    - Pali Canon (Selection)
    - Penelhum Religion and Rationality (Selection)
- Freedom to Choose
    - Libertarianism
    - James The Dilemma of Determinism (Selection)
    - Taylor Metaphysics (Selection)
    - Determinism
    - Hospers Meaning and Free Will (Selection)
    - Skinner Walden Two (Selection)
    - Compatibilism
    - State Religion and the Modern Mind (Selection)
    - Radhakrishnan Indian Philosophy (Selection)
- Ethics
    - Fulfilling Human Nature
    - Aristotle Nicomachean Ethics (selection)
    - Loving God
    - Augustine The Morals of the Catholic Church and the City of God (Selection)
    - Following Natural Law
    - Aquinas Summa Theologiae (Selection)
    - Doing One's Duty
    - Kant Fundamental Principles of the Metaphysics of Morals (Selection)
    - Maximizing Utility
    - Mill Utilitarianism (Selection)
    - Turning Values of Upside Down
    - Nietzsche Human, All too Human and Beyond Good and Evil (Selection)
    - Creating Ourselves
    - Sartre Existentialism is a Humanism (Selection)
    - Hearing the Feminine Voice
    - Gilligan In a Different Voice (Selection)
    - Baier What do Women Want in a Moral Theory (Selection)
- Political and Social Philosophy
    - The State as Natural
    - Plato the Republic (Selection)
    - Aristotle Politics (Selection)
    - The State as a Social Contract
    - Hobbes Philosophical Rudiments Concerning Government and Society (Selection)
    - Locke the Second Treatise of Government (Selection)
    - Liberty of the Individual

- Mill On Liberty (Selection)
- Alienation in Capitalism
- Marx Economic and Philosophic Manuscripts of 1844 (Selection)
- Justice and Social Trust
- Rawls A Theory of Justice (Selection)
- Nozick Anarchy, State, and Utopia (Selection)
- Held Rights and Goods (Selection)
- Women in Society
- Wollstonecraft A Vindication of the Rights of Women (Selection)
- De Behaviour The Second Sex (Selection)
- The Value of Philosophy
- Russel The Problems of Philosophy (Selection)
- Midgley Philosophical Plumbing (Selection)

Recommended Books:

The Books may be recommended by the University Concerned.

ENTREPRENEURSHIP 3+0

Knowledge Area / Sub Area: Social Science

Specific Objectives:

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

Course Outline:

Introduction: The concept of entrepreneurship, the economist view of entrepreneurship, the sociologist view, Behavioural approach, Entrepreneurship and Management

The Practice of Entrepreneurship: The process of entrepreneurship, Entrepreneurial Management, the entrepreneurial business, Entrepreneurship in service institutions, the new venture

Entrepreneurship and Innovation: The innovation concepts, Importance of innovation for entrepreneurship, Sources of innovative opportunities, the innovation process, Risks involved in innovation

Developing Entrepreneur: Entrepreneurial profile, Trait approach to understanding entrepreneurship, Factors influencing entrepreneurship, the environment, Socio cultural factors, Support systems

Entrepreneurship Organization: Team work, Networking organization, Motivation and compensation, Value system

Entrepreneurship and SMES: Defining SMEs, Scope of SMEs, Entrepreneurial, managers of SME, Financial and marketing problems of SMEs

Entrepreneurial Marketing: Framework for developing entrepreneurial marketing, Devising entrepreneurial marketing plan, Entrepreneurial marketing strategies, Product quality and design

Entrepreneurship and Economic Development: Role of entrepreneur in the economic development generation of services, Employment creation and training, Ideas, knowledge and skill development, The Japanese experience

Case Studies of Successful Entrepreneurs

Recommended Books:

1. Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship
2. P. N. Singh: Entrepreneurship for Economic Growth
3. Peter F. Drucker: Innovation and Entrepreneurship Peter F. Drucker
4. John B. Miner: Entrepreneurial Success

SECHEME OF STUDIES
BS/BE/BSc (Mechanical Engineering)

Note: *A sample for distribution of courses in different semesters is provided, however universities may make changes according to their available faculty and schedule.* ***Each lab course will be treated as a separate course.***

Semester/Term 1

	Subjects		**Credit Hrs**		**Credit Hours**
			Theory	**Lab**	
1	GS-101	Calculus and Analytical Geometry	3	0	3
2	GS-102	Applied Physics	2	1	3
3	GS-103	Applied Chemistry	2	1	3
4	HS-101	Functional English	3	0	3
5	CS-101	Computer Systems and Programming	2	1	3
6	ME-111	Engineering Drawing and Graphics	2	1	3
		Total:	**14**	**4**	**18**

Semester/Term 2

	Subjects		**Credit Hrs**		**Credit Hours**
			Theory	**Lab**	
1	IS-101	Islamic Studies/Ethics	2	0	2
2	EE-101	Electrical Engineering	2	1	3
3	GS-104	Linear Algebra and Ordinary Differential Equations	3	0	3
4	HS-102	Communication Skills	2	0	2
5	ME-112	Workshop Practice	0	2	2
6	ME-113	Engineering Mechanics-I: Statics	3	0	3
7	ME-121	Thermodynamics-I	3	0	3
		Total:	**15**	**3**	**18**

Semester/Term 3

	Subjects		Credit Hrs		Credit Hours
			Theory	Lab	
1	IS-201	Pakistan Studies	2	0	2
2	ME-211	Engineering Mechanics-II: Dynamics	3	1	4
3	ME-212	Mechanics of Materials–I	3	0	3
4	ME-213	Engineering Materials	3	0	3
5	ME-221	Thermodynamics-II	3	1	4
6	ME-222	Fluid Mechanics-I	3	0	3
		Total:	**17**	**2**	**19**

Semester/Term 4

	Subjects		Credit Hrs		Credit Hours
			Theory	Lab	
1	EE-201	Electronics Engineering	2	1	3
2	GS-201	Complex Variables and Transforms	3	0	3
3	GS-202	Social Sciences (Elective)	2	0	2
4	ME-214	Machine Design and CAD-I	2	1	3
5	ME-215	Mechanics of Materials–II	3	1	4
6	ME-223	Fluid Mechanics-II	3	1	4
		Total:	**15**	**4**	**19**

Semester/Term 5

	Subjects		Credit Hrs		Credit Hours
			Theory	Lab	
1	HS-301	Technical Report Writing and Presentation Skills	3	0	3
2	GS-301	Numerical Analysis	3	0	3
3	ME-311	Machine Design & CAD-II	3	1	4
4	ME-312	Precision Engineering and Metrology	2	1	3
5	ME-321	Heat & Mass Transfer	3	1	4
		Total:	**14**	**3**	**17**

Semester/Term 6

	Subjects		Credit Hrs		Credit Hours
			Theory	**Lab**	
1	GS-302	Applied Statistics	3	0	3
2	ME-313	Manufacturing Processes	3	1	4
3	ME-314	Control Engineering	2	1	3
4	ME-315	Mechanics of Machines	3	1	4
5	ME-322	Refrigeration and Air Conditioning	3	1	4
		Total	**14**	**4**	**18**

Semester/Term 7

	Subjects		Credit Hrs		Credit Hours
			Theory	**Lab**	
1	MS-401	Engineering Economics	2	0	2
2	ME-411	Mechanical Vibrations	3	1	4
3	ME-421	Internal Combustion Engines	2	1	3
4	ME-4xy	Technical Elective-I	3	0	3
5	ME-499	Project	0	3	3
		Total:	**10**	**5**	**15**

Semester/Term 8

	Subjects		Credit Hrs		Credit Hours
			Theory	**Lab**	
1	ME-4xy	Technical Elective-II	3	0	3
2	ME-4xy	Technical Elective-III	3	0	3
3	MS-4xy	Management Elective	3	0	3
4	ME-499	Project	0	3	3
		Total:	**9**	**3**	**12**
		Grand Total:	**108**	**28**	**136**

Non Engineering Courses Credit Hours	40
Engineering Courses Credit Hours	96

COURSE CODE METHODOLOGY

The following course code methodology is followed for the curriculum and syllabus of this program

- The first two alphabets in the course code indicate the discipline being referred to, for example, ME for Mechanical Engineering
- The first digit in the course code indicates the academic year during which the course is offered. The second digit indicates the stream and third digit indicates the sequence of the course in the respective area in that year.

Second Digit	**Stream**
0	Non Mechanical Engineering Courses
1	Design and Manufacturing Courses
2	Thermo fluid Courses

- For different domain abbreviation used are as follow

ME:	Mechanical Engineering
EE:	Electrical Engineering
CS:	Computer Systems Engineering
GS:	General Sciences
HS:	Humanities Sciences
MS:	Management Sciences
IS/PS:	Islamic Studies/Pakistan Studies

DETAIL OF COURSES
ENGINEERING DOMAIN

Title of the Course: COMPUTER SYSTEMS AND PROGRAMMING (CS-101)

Credit Hours: 2, 1

Specific Objectives:

- To learn fundamentals of computer hardware and basic terminologies.
- To learn structure programming to solve the engineering problems.

Course Outline:

Introduction to Computers. Computer components and systems, Networks, Operating Systems. Input/output devices, CPU, Primary and secondary storage devices.
Software: Word Processing, Spreadsheets, Presentation software, Internet Browsers & E-mail.
Introduction to Programming. Flowcharts, Pseudo codes, logical gates.

Lab Outline:

Programming in C++. Structural Programming, logical and mathematical operators, loops, conditional statements, arrays, functions.

Recommended Books:

1. Turbo C, By Robert Lafore
2. Programming with C++, Schaum's Series
3. Turbo C, By Deitel & Deitel

Title of the Course: ENGINEERING DRAWING AND GRAPHICS (ME-111)

Credit Hours: 2, 1

Specific Objectives:

- To inculcate in students the ability to comprehend the science of Engineering Drawing so that they are able to convey their creative ideas effectively.
- To provide the link from conventional 2D drawings

Course Outline:

Introduction. Types of lines, lettering, dimensioning, use of pencil and drawing instruments, planning of drawing sheet.

Projections. Types of projections, orthographic projections, plane of projections, four quadrants, projection of points, projection of straight lines, examples with different quadrants, traces of a line, true length of a line, inclination to both the planes, projection of oblique and auxiliary planes.

Loci of Points and Generated Curves. Loci of points and straight lines. Cycloid, epicycloid, involute, archemedian spiral.

Development of Solids. Types of solids, polyhedra, solids of revolution, prism, pyramid, cylinder, cone, sphere.

Intersection of Surfaces. Intersection of cylinder and cylinder, cone and cylinder, cone and cone, cone and prism.

Projection of Solids. Projection of various solids in simple position and inclined positions.

Section of Solids. True shape of section on auxiliary plane of various solids.

Lab Outline:

Isometric and pictorial projections of solids/machine parts, making of freehand sketches from solid objects and from orthographic projections. Sections of joints, screw thread systems, nuts and bolts, keys and cotter, coupling and bearings.

Recommended Books:

1. Technical Graphics Communication By Bertoline Wiebe, Miller. Mohler, Irwin McGraw-Hill
2. Practical Geometry & Engineering Graphics By Abbot.
3. Engineering Graphics By Craft, Meyers & Boyer
4. Technical Graphics Communication, *By Gary R. Bertoline and Eric N. Wiebe*; McGraw-Hill
5. Mathematical Elements for Computer Graphics *By D. F. Rogers and J. A. Adams*; McGraw-Hill

Title of the Course: WORKSHOP PRACTICE (ME-112)

Credit Hours: 0, 2

Specific Objectives:

- To learn the basic operations of Machine, Fitting, Electric, Carpentry and Smithy shops.
- To get hands on experience on various machines.
- To learn the use various tools.

Lab Outline:

Fitting Shop. Assembly/disassembly of basic mechanical components.
Wood-Work Shop. Timber and its type, defects, and preservation methods, different types of wood joints.

Electric Shop. Types and uses of cables. Types of electric circuits, electrical appliances.
Forging & Foundry Shop. Tools and accessories, furnace types, casting.
Machine Shop. Introduction to machine tools, basic lathe operations.
Welding Shop. Soldering, brazing and welding.

Students will be assigned practical jobs in relevant shops.

Recommended Books:

1. Workshop Technology, By W. A. J Chapman Butterworth-Heinemann
2. Electrical Wiring By Richter and Schwan McGraw-Hill Education
3. Wiring Manual By Pak Cables Limited.

Title of the Course: ENGINEERING MECHANICS-I: STATICS (ME-113)

Credit Hours: 3, 0

Specific Objectives:

- To gain basic understanding of various engineering structures in equilibrium.
- To develop knowledge regarding physical phenomena in mathematical terms

Course Outline:

Force System. Force, rectangular components, moment, couples, resultant of forces, moments and couples (two and three dimensional systems).
Equilibrium. Mechanical systems, isolation and equilibrium equations for two and three dimensional systems. Free body diagram, two force and three force members.

Structures. Plane trusses, method of joints, method of sections, frames and machine analysis. Forces in beams and cables

Friction. Types of friction, dry friction, application of friction.

Lab Outline:

The experiments of Engineering Mechanics-I will be conducted with Engineering Mechanics-II.

Recommended Books:

1. Vector Mechanics for Engineers by Beer and Johnston
2. Engineering Mechanics (Statics) by J. L. Meriam
3. Engineering Mechanics (Statics) by R. C. Hibbler

Title of the Course: THERMODYNAMICS-I (ME-121)

Credit Hours: 3, 0

Specific Objectives:

- To gain basic concepts of thermodynamics and its laws, conservation of energy and cycle concepts.
- Properties of working fluids

Course Outline:

Basic concepts: the system, control volume, working substance, heat and work, state and properties, thermodynamic process and cycle, first law of thermodynamics, ideal gas laws, equations of state, thermodynamic temperature scale, concept of open and closed cycles

Properties of pure substances: phase diagram, use of steam tables.

Thermodynamic processes relationship: constant volume, constant pressure, constant temperature, constant enthalpy and general law processes, steady state and steady flow process, uniform state and uniform flow processes, steady flow energy equation and steady flow devices.

Second law of thermodynamics: definitions, applications, reversible and irreversible processes, Carnot cycle and concept of entropy and its application to flow and non-flow processes, enthalpy-entropy diagrams of working fluids, thermodynamic cycles, efficiencies, and their applications, Idealized P-V and T-S diagrams of cycles, Rankine cycle and its application.

Lab Outline:

The experiments of Thermodynamics-I will be conducted with Thermodynamics-II.

Recommended Books:

1. Thermodynamics, An Engineering Approach, *By Yunus A. Cengel,Michael A. Boles* McGraw-Hill
2. Fundamentals of Engineering Thermodynamics, *By M. J. Moran and H. O. Shapiro,* John Wiley & Sons
3. Fundamentals of Thermodynamics**,** *By Sonntang, Borgnakke,Van Wylen* John Wiley & Sons
4. Applied Thermodynamics for Engineering Technologists, By T. D. Eastop and A. McConkey

Title of the Course: ENGINEERING MECHANICS-II: DYNAMICS (ME-211)

Credit Hours: 3, 1

Specific Objectives:

- To gain fundamental concepts of bodies under dynamic conditions
- To implement laws of motions to components / structures under the influence of forces

Course Outline:

Kinematics of Particles. Rectilinear motion, plane curvilinear motion, rectangular coordinates, normal and tangential coordinates polar coordinates.

Kinetics of Particles. Force, mass, and acceleration, Newton's second law of motion, equations of motion, kinetic diagrams, rectilinear motion, curvilinear motion. Work and energy, potential energy. Impulse and momentum, conservation of momentum.

Plane Kinematics of Rigid Bodies. Angular motion relations, absolute motion, relative velocity, instantaneous centre of zero velocity, relative acceleration.
Plane Kinetics of Rigid Bodies: Force, mass, and acceleration, equation of motion, translation, fixed axis rotation, general plane motion, work and energy relationship, impulse and momentum equation.

Lab Outline:

Experiments related to the course outline of Engineering Mechanics-I & II will be covered in the Lab class.

Recommended Books:

1. Vector Mechanics for Engineers (Dynamics) by Beer and Johnston

2. Engineering Mechanics (Dynamics) by J. L. Meriam
3. Engineering Mechanics (Dynamics) by R. C. Hibbler

Title of the Course: MECHANICS OF MATERIALS-I (ME-212)

Credit Hours: 3, 0

Specific Objectives:

- To gain basic understanding of the concepts of solid mechanics and familiarize students with the methods of analysis.
- To study the response of different engineering materials under various types of loadings.

Course Outline:

Mechanical properties of materials, tensile, compressive and shear stress & strain, Hooke's law, stress strain relationship, thermal stresses, torsion of circular bars, shearing force and bending moment, pure bending of beams, shear stresses in beams, beam deflection using various methods, residual stresses, analysis of statically indeterminate problems, stress concentration, thin and thick curved bars, thin walled pressure vessels.

Lab Outline:

The experiments of Mechanics of Materials-I will be conducted with Mechanics of Materials-II.

Recommended Books:

1. Mechanics of Materials *by Ferdinand P. Beer & Russel Johnston Jr.* McGraw-Hill
2. Mechanics of Materials by R. C. Hibbler
3. Mechanics of Engineering Materials *by P. P. Benham & R. J. Crawford* Longman Sc & Tech
4. Mechanics of Materials by Popov

Title of the Course: ENGINEERING MATERIALS (ME-213)

Credit Hours: 3, 0

Specific Objectives:

- To understand the appropriate use and selection of various engineering materials in designing and manufacturing of components and associated processes.
- To acquire knowledge related to the microstructure of engineering materials

Course Outline:

Metals

Structure of Metals: Crystalline structure of metals, allotropy. Crystallographic planes, mechanisms in metals, slip and slip systems, dislocation, twinning, yield phenomenon and strain aging, Bauchinger effect.

Metals and Alloy Systems: Production of iron, wrought iron, cast iron. Production of steel and its classification, ferrite, austenite, S-iron, cementite, pearlite, martensite, bainite, etc. Iron-carbon phase diagram, alloying elements and their effect on the properties of alloy steel. Refining of copper, aluminum and zinc. Aluminum alloys, zinc alloys, copper alloys, brass and bronzes. Metals and alloys for special application. Corrosion of metals anti-corrosive coatings and paints.

Material Forms and Designation: Heat treatment critical temp, transformation on heating/cooling, annealing, normalizing, tempering, quenching, austempering, hardening, rolling processes and production of various steel sections such a billet, bar, rod, channel, Roll load calculation, British standards and ASTM standard specification on iron/steel.

Non Metals

Composition, properties and uses of plastics, rubber, ceramics, fiberglass, composite materials and polymers.

Polymers: Molecular structure, bonding & classification of polymer compounding, forming operations etc., plastics.

Ceramics and refractories: Ceramic bonding, properties, ceramics material, crystalline and amorphous, silica, glass etc., refractory materials and their types, Introduction to Composite Materials**,** Material failure analysis.

Recommended Books:

1. Materials and Processes in Manufacturing, *By E. P Degarmo* Prentice Hall
2. Process and Materials of Manufacturing *By Lindberg*.
3. Ceramic Science for Materials Technologist *By T. J McCalm*
4. Engineering with polymers *By P. C. Powell* Springer
5. Introduction to Engineering Materials *By William F. Smith* McGraw-Hill Science
6. Material Science *By David Collister*

Title of the Course: THERMODYNAMICS-II (ME-221)

Credit Hours: 3, 1

Specific Objectives:

- To introduce turbo-machinery (Turbines, compressors and engines etc.)
- To study the behavior of ideal and real gas mixtures.
- Understanding of different thermodynamic systems and to deal with real-world engineering problems in order to improve the performance of such systems.

Course Outline:

Mixture with chemical reaction: Combustion reaction equations, stoichiometric chemical reaction, air-fuel ratio, rich and lean mixtures, enthalpy of formation.

Compressors: classification and working principles, single stage and multistage compressors, inter-cooling, efficiencies and P-V diagrams of reciprocating compressors, velocity diagrams of centrifugal compressors, performance characteristics and working regimes.

Boilers: generation of steam through boilers, classification and configurations of boilers and their applications, boiler efficiencies and heat balance sheet.

Nozzles: Introduction to nozzles, flow through steam nozzle and its efficiencies, their classification working principles.

Turbines: Steam turbine, their classification and working principles.

Introduction to internal combustion engines: Two and four-stroke engines, SI and CI engines, carburetion and fuel injection system.

Lab Outline:

Experiments related to the course outline of Thermodynamics-I & II will be covered in the Lab class.

Recommended Books:

1. Fundamentals of Engineering Thermodynamics, *By M. J. Moran and H. O. Shapiro,* John Wiley & Sons
2. Fundamentals of Thermodynamics, *By Sonntang,Borgnakke,Van Wylen* John Wiley & Sons
3. Thermodynamics, An Engineering Approach, *By Yunus Cengel, Michael A. Boles* McGraw-Hill
4. Applied Thermodynamics for Engineering Technologists, By T. D. Eastop and A. McConkey
5. Basic Engineering Thermodynamic, By Rayner Joel Prentice Hall

Title of the Course: FLUID MECHANICS-I (ME-222)

Credit Hours: 3, 0

Specific Objectives:

- To introduce the basic principles of fluid mechanics.
- Understanding the basic concepts in fluid static and fluid dynamics.

Course Outline:

Fluid Properties: Ideal and real fluids, viscosity and compressibility of fluids, fluid pressure, absolute, gauge and vacuum pressures, difference between static and dynamic pressure, flow velocity and flow rate

Fluid statics: Measurement of static pressure, stagnation pressure, pressure in a fluid under the action of gravity, homogeneous fluid, constant-velocity rotation of a liquid around-fixed axis, hydraulic circuits, force on container wall, force on flat surfaces, force on curved surfaces, buoyancy of fluid at rest, stability of a floating body, surface tension and capillary tubes.

Fluid dynamics: One dimensional inviscid flow (flow filament theory), equation of continuity, Euler's equations of motion, Bernoulli's equation, impulse and momentum, one dimensional viscous flow, generalized Bernoulli's equation, flow in conduits

Dimensional analysis, similitude and its applications: Buckingham- Pi theorem, Reynolds' law of similitude

Lab Outline:

The experiments of Fluid Mechanics-I will be conducted with Fluid Mechanics -II.

Recommended Books:

1. Fundamentals of Fluid Mechanics, *By Munson, Young and Okiishi,* John Wiley & Sons
2. Fluid Mechanics, *By Frank M. White* McGraw-Hill
3. Fluid Mechanics by Shames McGraw-Hill. McGraw-Hill Science/Engineering/Math.
4. Engineering Fluid Mechanics, *By Clayton T. Crowe, Donald F. Elger, John A. Roberson,* John Wiley & Sons

Title of the Course: MACHINE DESIGN AND CAD-I (ME-214)

Credit Hours: 2, 1

Specific Objectives:

- To design common machine elements and to gain experience in solving design problems.
- To prepare professional quality solutions and effectively communicate the results of analysis and design.

Course Outline:

Basic criteria of design of machine parts, determination of permissible and actual stresses, factor of safety, design of keys, cotters, and couplings, Design of brakes and clutches, flywheel, Design of welded, riveted and bolted joints, Design of translation screws, Design codes and standards, tolerances, standards of fits & tolerances. Fundamentals of CAD.

Lab Outline:

Two & Three Dimensional modeling of machine components using CAD software.

Recommended Books:

1. Mechanical Engineering Design, *By J. E. Shigley,* McGraw-Hill
2. Machine Design, An Integrated Approach, *By R L Norton,* McGraw-Hill.
3. Design of Machine Elements, *By M. F. Spotts,* Prentice Hall
4. Fundamentals of Machine Component Design, By R. C. Juvinall & K. M. Marshek, John Wiley
5. Related CAD software user's guide

Title of the Course: MECHANICS OF MATERIALS-II (ME-215)

Credit Hours: 3, 1

Specific Objectives:

- To gain advanced understanding of the mechanical behavior of materials such as plastic deformation.
- Study of 3-D stress analysis

Course Outline:

Analysis of stress and strain in two and three dimensions, principal stresses and strains, Mohr's circle for stress and strain, thick walled cylinders, symmetrical and asymmetrical loading, introduction to fracture mechanics, impact loading, fatigue and creep, virtual work, theories of failure. Theory of columns.

Lab Outline:

Experiments related to the course outline of Mechanics of Materials-I & II will be covered in the Lab class.

Recommended Books:

1. Mechanics of Materials *by Ferdinand P. Beer & Russel Johnston Jr.* McGraw-Hill

2. Mechanics of Materials by R. C. Hibbler
3. Mechanics of Engineering Materials *by P. P. Benham & R. J. Crawford* Longman Sc & Tech
4. Mechanics of Materials by Popov

Title of the Course: FLUID MECHANICS-II (ME-223)

Credit Hours: 3, 1

Specific Objectives:

- To understand the working of Turbo-machinery (Pumps, Turbines, etc.)
- To understand and use boundary layer and differential equations to determine parameters in internal and external flows.
- Understand the concept of Non-Newtonian flows.
- To study compressible flow

Course Outline:

Two and three dimensional ideal fluid flow
Potential flow, circulation, stream function and velocity potential, uniform flow, two dimensional source and sink, vortex, the doublet, lift and drag forces.

Two and three dimensional viscous fluid flow
Navier stokes equations of motion, two dimensional flow between parallel plates, flow in a circular pipe, creep flow, Reynold's equation, hydrodynamic lubrication in journal bearing.

Boundary layer theory
Boundary layer theory, laminar & turbulent boundary layers, boundary layer control, airfoil cascades.

Fluid machinery
Similarity relations for turbo machines, specific speed, classification of turbo machines, impulse turbines, reaction turbines, hydraulic jacks, pumps and their performance curves.

Computational fluid dynamics
Introduction, numerical operations for differentiation and integration, programming procedure, simple exercise problems.

Lab Outline:

Experiments related to the course outline of Fluid Mechanics-I & II will be covered in the Lab class.

Recommended Books:

1. Fundamentals of Fluid Mechanics, *By Munson, Young and Okiishi* John Wiley & Sons
2. Fluid Mechanics, *By Frank M. White,* McGraw-Hill
3. Fluid Mechanics, By Shames, McGraw-Hill.
4. Engineering Fluid Mechanics, *By Clayton T. Crowe, Donald F. Elger, John A. Roberson*, John Wiley & Sons

Title of the Course: MACHINE DESIGN AND CAD-II (ME-311)

Credit Hours: 3, 1

Specific Objectives:

- To design common machine elements and to gain experience in solving design problems.
- To prepare professional quality solutions and to effectively communicate the results of analysis and design.

Course Outline:

Kinematics, force analysis and design of spur, helical, bevel & worm gears, design of rolling contact bearings, hydrodynamic theory of lubrication, journal bearings, mechanical springs, design of belts, ropes and chains, design of shafts. Introduction to experimental stress analysis. Introduction to Finite Element Analysis.

Lab Outline:

Assembly modelling and generation of engineering drawings using related CAD software. Use of Finite Element Analysis software to solve related engineering problems.

Recommended Books:

1. Mechanical Engineering Design, *By J. E. Shigley,* McGraw-Hill
2. Machine Design, An Integrated Approach, *By R L Norton,* McGraw-Hill.
3. Design of Machine Elements, *By M. F. Spotts,* Prentice Hall
4. Fundamentals of Machine Component Design, By R. C. Juvinall & K. M. Marshek, John Wiley
5. Related CAD and FEA software user's guide

Title of the Course: PRECISION ENGINEERING AND METROLOGY (ME-312)

Credit Hours: 2, 1

Specific Objectives:

- To understand the methods and principles of instrumentations of various systems.
- To learn the basic method to measure various parameters.

Course Outline:

Significance of measurement, planning of experiments, general measurement system, calibration, static and dynamic measurement sensitivity, range, accuracy precision, repeatability, and uncertainty of instruments, measurement errors, instruments for measurement of length, force, torque, strain, frequency, pressure, flow, and temperature. Introduction to data acquisition systems, A/D and D/A converters.

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

1. Measurement Systems Applications and Design*, By E. Doeblin*, McGraw Hill
2. Theory and Design for Mechanical Measurements, *By R. Figliola, And D. Beasley*, John Wiley.

Title of the Course: HEAT AND MASS TRANSFER (ME-321)

Credit Hours: 3, 1

Specific Objectives:

- Understanding of basic principles of heat & mass transfer involved in thermo-fluids as well as another related fields.
- To design main mechanical component of industries e.g. heat exchanger, boilers, condensers, evaporators.

Course Outline:

Conduction

Heat equation, Fourier's law, one dimensional steady state heat conduction through plane and composite walls, cylinders and spheres with and without heat generating sources, critical thickness of insulation, heat transfer through extended surfaces, transient conduction, lumped capacitance method.

Convection

Newton's law of cooling, boundary layer, natural (free) and forced convection heat transfer. coefficient of heat transfer for free and forced convection, effects of laminar, transition and turbulent flow on coefficient of heat transfer, flow over flat plates, heat transfer for flow through pipes and ducts, non-dimensional parameters related to heat transfer and their applications. Shear stresses, friction coefficient for fully developed flow, Reynolds analogy, heat transfer with phase change, boiling, condensation.

Radiation

Stefan Boltzmann's law, black body radiation, absorptivity, reflectivity, transmissivity. Wien's Displacement law, Kirchoff's law, gray body radiation. Radiation shape factor and its applications.

Mass transfer
Ficks law and its application, analogy between momentum, heat and mass transfer.

Heat exchangers
Classification, overall heat transfer coefficient. LMTD and NTU methods.

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

1. Fundamentals of Heat Transfer *By Incropera & DeWitt*, John Wiley & Sons
2. Heat Transfer, A Practical Approach *By Y. A. Cengel*, McGraw-Hill
3. Heat Transfer *By J. P. Holman,* McGraw-Hill
4. Elements of Heat Transfer by *Frank Keith*, International Text Books Co.

Title of the Course: MANUFACTURING PROCESSES (ME-313)

Credit Hours: 3, 1

Specific Objectives:

- To understand various manufacturing processes.
- To get hands on experience on various types of machine tools.
- To apply effectively various manufacturing techniques/operations used in broad spectrum of engineering and manufacturing companies.

Course Outline:

Forming & shaping processes and equipment, material removal, cutting tools, machining processes for producing various shapes, extrusion and drawing, sheet metal forming, forming & shaping plastics & composite materials, joining process & equipment, solid state welding process, metal casting process & equipment: powder metallurgy, surface treatment, non-conventional machining process, jigs & fixtures.

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

1. Fundamentals of Modern Manufacturing, By M. P. Groover John Wiley & Sons
2. Manufacturing Engineering and Technology By Kalpakjian Prentice Hall

3. Materials and Processes in Manufacturing By E. P Degarmo Prentice Hall
4. Process and Materials of manufacture By F. A Lindberg.
5. Introduction to Manufacturing Process By John Aschey.
6. Manufacturing Process By B. H Amstead, P. F Ostwald.

Title of the Course: CONTROL ENGINEERING (ME-314)

Credit Hours: 2, 1

Specific Objectives:

- To gain basic understanding and implementation of various control systems
- To learn mathematical modeling of various systems

Course Outline:

Basic concepts

System, control system, input, output, open-loop and closed loop control systems, elements of a general control system, examples of control system.

Mathematical modeling of physical system

Operational notation, grounded chair representation, series parallel, laws, equations of motion for spring mass damper systems, levered system, rotational system, geared system, electrical components and R. L. C circuits, electrical analogies for mechanical systems, scale factors, thermal systems and fluid system.

Transfer functions and systems response

Review of Laplace transform, impulse, step and ramp functions, concept of transfer functions of common components, block diagram algebra, signal flow graphs, impulse, step, and ramp response of first and second order systems, characterization of response (time constant, gain, overshoot, rise time, settling time, steady state error, etc.) relation of system response to location of system poles and zeros.

Stability of control system

Concept of stability, Routh Hurwitz criterion, root locus methods and its use in control System design, digital control.

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

1. Automatic Control Systems, *By B. C. Kuo, F. Golnaraghi*, John Wiley & Sons.
2. Modern Control System, *By Richard C. Dorf,* Prentice Hall.
3. Automatic Control, *By J. J. Distofano et al*.
4. Automatic Control, *By Francis H. Raven*.

Title of the Course: MECHANICS OF MACHINES (ME-315)

Credit Hours: 3, 1

Specific Objectives:

- To understand the mechanics and mechanisms involved in various machine elements
- To learn the application of various machine components.

Course Outline:

Simple mechanism, screw threads and efficiency, friction of pivot, collar and conical bearing, cone, plate and centrifugal clutch, belts and rope drives, chains and sprockets, bands and shoe brakes, governors, effort and power, sensitivity, controlling force and stability, gyroscope, geometry of gears, gear trains, dynamometers. Linkages: synthesis and analysis, position, velocity and acceleration analysis, turning moment diagram, flywheels, cam and follower, steering gears, balancing.

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

1. Theory of Machines and Mechanisms, *By J. E. Shigley & Uicker,* McGraw-Hill
2. Mechanism Design, *By Erdman and Sanders*, McGraw-Hill.
3. Principles of Mechanisms, *By F. Dyson,* Oxford University Press.
4. Theory of Machines, *By W.G. Green* Blackie & Son.

Title of the Course: REFRIGERATION AND AIR CONDITIONING (ME-322)

Credit Hours: 3, 1

Specific Objectives:

- To understand refrigeration systems.
- To develop basic ideas about cycle analysis and designing parameters pertaining to refrigeration and air conditioning systems
- To deal with the problems related to architectural, building services, HVAC, equipment

Course Outline:

Refrigeration cycles

Reversed Carnot and Joule Cycles, vapour compression and vapour absorption systems, COP, pressure- enthalpy chart, types of refrigerants, air cycle refrigeration, multiple effect compression, multi-stage compression, heat pumps

Air conditioning
Indoor and outdoor air conditions, comfort conditions and comfort zone, indoor air quality, psychrometry.

Central air-conditioning system
Essential components of central air-conditioning plant, water chiller and water heater, air handling unit, chilled water and hot water recirculation system, return air supply system, fresh air supply system air mixture chamber, supply fan, air dust cleaning and bacteria removal, air supply and air return terminals, diffusers and grilles, CFM rating and tons of air-conditioning of a central air-conditioning plant.

Load calculation and system design
Cooling and heating load calculation procedures, duct sizing and piping design, pumps and fans selection, air ventilation: calculation of fresh air supply of a multi-story building, air handling unit for untreated fresh air, forced convection based air ventilator design.

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

1. Heating, Ventilating, and Air-Conditioning Analysis and Design**,** *By McQuiston, Parker and Spitler* John Wiley & Sons
2. Heating and Cooling of Buildings, *By Ed. Kreider, Curtiss & Rabl* McGraw-Hill
3. Principles of Refrigeration, By Dossat, R. J., John Wiley
4. HVAC Systems Design Handbook, *By Haines, Roger W. Wilson, Lewis* McGraw-Hill Companies
5. ASHRAE Handbook

Title of the Course: MECHANICAL VIBRATIONS (ME-411)

Credit Hours: 3, 1

Specific Objectives:

- To determine the effect of vibration on the performance and safety of systems.
- To control the effects of vibration.

Course Outline:

Oscillatory motion: Elements of vibrating system, harmonic motion.

Single degree of freedom systems: equation of motion: Newton's method, energy method, finding natural frequencies, Rayliegh method and Holzer method,

undamped free vibration, viscously damped free vibration, logarithmic decrement, harmonically excited vibration, vibration isolation, vibration measuring instruments.

Two degree of freedom systems: normal modes of vibration, coordinate coupling, forced harmonic vibration, vibration absorber, vibration damper, orthogonality conditions.

Vibration of elastic bodies: free and forced vibration of cables and uniform bars, free and forced lateral vibrations of simply supported thin beams, torsional vibration of circular shafts with single rotor and two rotors, critical speed of rotating shafts.

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

1. Mechanical Vibrations: Theory & Applications, *By W. T. Thompson* Prentice Hall
2. Mechanical Vibrations, *By S. S. Rao*. McGraw-Hill
3. Elements of Vibration Analysis *By L. Meirovitch*, McGraw-Hill
4. Vibration for Engineers *By Endrew Dimargonas*, Prentice Hall

Title of the Course: INTERNAL COMBUSTION ENGINES (ME-421)

Credit Hours: 2, 1

Specific Objectives:

- To learn the working principles of various types of internal combustion engines, their components, performance and their applications
- To gain the knowledge of internal combustion engines emissions on environment
- To understand the use of alternative fuels

Course Outline:

Engine classification, working principles of SI and CI engines, working principle of turbo-charged engine, its performance characteristics. Testing and performance characteristics of petrol and diesel engines under variable conditions of load and speed, knocking characteristics, ignition advance and retard, pressure-crank angle diagram, combustion phases of SI and CI engines.

Engine emissions and their control through in-cylinder and out-cylinder techniques, exhaust gas recirculation (EGR) system, thermal reactor and catalytic converters, EFI engines and advantages over conventional petrol engine, engine performance

under part-load conditions, introduction to dual fuel engines, alternative fuels, engine lubrication and lubricants.

Lab Outline:

Experiments related to the course outline mentioned above will be covered in the Lab class.

Recommended Books:

1. Internal Combustion Engine Fundamentals By J. B. Heywood McGraw-Hill
2. Introduction to I. C. Engines By Richard Stone Palgrave Macmillan
3. Internal combustion engines By C-F Taylor. MIT Press

TECHNICAL ELECTIVE COURSES

Title of the Course: POWER PLANTS

Credit Hours: 3, 0

Specific Objectives:

- To gain understanding of working principles of various types of power plants operating on conventional as well as renewable energies
- To learn the methods of trouble shooting, maintenance and optimization of various types of power plants

Course Outline:

Conventional power plants
Steam turbine, gas turbine, combined cycle, jet engine, diesel engine, nuclear, hydro-electric and combined heat and power plants (CHP).

Non-Conventional power plants
Solar, wind, geothermal, ocean waves and tidal power plants.

Recommended Books:

1. Power Plant Technology, *By M. M. El Wakil,* McGraw-Hill
2. Power Plant, *By F. T. Morse*
3. Applied Thermodynamics for Engineering Technologist, By T. D. Eastop & J. McConkey

Title of the Course: RENEWABLE ENERGY RESOURCES

Credit Hours: 3, 0

Specific Objectives:

- To understand exploration of various energy sources.
- To understand the concepts of energy conversion systems
- To implement the ways of energy conservation and management.

Course Outline:

Introduction to types of renewable energy, solar energy, tidal wave and geothermal energy, biomass energy, fuel cell and heat pump systems, energy efficiency issues and energy storage, potential of using renewable energy resources as supplement of conventional energy resources.
Renewable and non-renewable energies used as hybrid energy systems, modern renewable energy plants.

Wind energy, wind turbine design specifications, compatible electric generators and major operational, wind mills design usage for pumping water.
Biomass energy conversion methods, detailed description of synthetic gas, biodiesel, biomass and biogas, operational and maintenance problems and their remedies.

Recommended Books:

1. Renewable Energy, By Godfrey Boyle, Oxford University Press
2. Renewable Energy Resources, By john Twidell, Tony Weir, Spon Press
3. Renewable Energy Conversion, Transmission and Storage, By Bent Sorensen

Title of the Course: MECHATRONICS

Credit Hours: 3, 0

Specific Objectives:

- To acquire fundamental knowledge for electro mechanical design.
- To develop synergistic integration of mechanical, electrical, electronic engineering applications

Course Outline:

Introduction
Sensors and transducers, transducer characteristics, sensors for measuring displacement, strain, force, pressure, temperature and motion, encoders.

Computer architecture
Microprocessor, micro-programming, Bus systems, assembly language programming

Motors with drivers
Stepper and servo motors, introduction to programmable logic controller (PLC).

Interfacing
Ports, input/output, analog to digital converter, sampling theory, digital to analog converter, sample and hold, multiplexer, interfacing switches, LEDs, stepper motors and DC motors to micro-controllers.
Introduction to condition monitoring, and sensor fusion.

Recommended Books:

1. Design with Microprocessors for Mechanical Engineers, By A. K. Stiffler, McGraw-Hill
2. Microprocessor Architecture, Programming and Applications, By Goankr, Prentice Hall
3. Introduction to Mechatronics & Measurement Systems By David G. Akiatore, Michael B. Histard
4. Mechatronics An integrated approach By Clarence W. Desilva

Title of the Course: TRIBOLOGY

Credit Hours: 3, 0

Specific Objectives:

- To understand the tribological systems:
- To design the interfaces between two or more bodies in relative motion.

Course Outline:

Fundamental topics include: geometric, chemical, and physical characterization of surfaces; friction and wear mechanisms for metals, polymers, and ceramics, including abrasive wear, delamination theory, tool wear, erosive wear, wear of polymers and composites; and boundary lubrication and solid-film lubrication. The course also considers the relationship between nano-tribology and macro-tribology, rolling contacts, tribological problems in magnetic recording and electrical contacts, and monitoring and diagnosis of friction and wear. Case studies are used to illustrate key points.

Recommended Books:

1. Engineering Tribology, by G. W. Stachowiak.
2. Tribology, Friction and Wear of Engineering Materials by I.M. Hutchings.

Title of the Course: MAINTENANCE ENGINEERING

Credit Hours: 3, 0

Specific Objectives:

- To understand the significance of maintenance engineering.
- To understand the concepts of maintenance engineering.
- To implement the ways of maintenance engineering.

Course Outline:

Introductory aspects concerning engineering maintenance, Maintenance management and control, Preventive maintenance (PM), Various aspects of corrective maintenance (CM) Reliability-centered maintenance, Quality maintenance processes, Modern maintenance, Maintainability management in system life cycle.

Recommended Books:

1. Maintenance Engineering Handbook by R. K Mobley, L. R. Higgins, D. J. Wikoff, McGraw-Hill
2. Maintenance Engineering & Management by R.C. Mishra, K. Pathak, Prentice Hall of India
3. Engineering Maintenance, A Modern Approach by B. S. Dhillon, CRC Press London

Title of the Course: INTRODUCTION TO FINITE ELEMENT METHOD

Credit Hours: 2, 1

Specific Objectives:

- To understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis
- To understand the importance of analysis and design, using the FEM, in the broader context of engineering practice

Course Outline:

Introduction to stress analysis by FEM, Basic concepts, Types of elements, linear static analysis, Review of the basic continuum theory, 1-D and 2-D FEM problems, Plane stress and plane strain problems, energy method, variational principles and Ritz's methods; co-ordinate transformation; isoparametric formulation, solution of eigen value, boundary value, discretized time dependant problems, use of commercial finite element code, project based learning of FEM.

Recommended Books:

1. An Introduction to the Finite Element Method, J. Reddy, McGraw-Hill.
2. The Finite Element Method: Principles and Applications By P. E. Lewis, J. P. Ward. Addison-Wesley Publishing Co. 1991
3. Advanced Strength and Applied Stress Analysis **2nd Edition,** By Richard G. Budynass, McGraw-Hill
4. Finite Element Analysis-Theory and Application **2nd Edition,** By Saeed Moaveni, Prentice Hall

Title of the Course: COMPUTATIONAL FLUID DYNAMICS

Credit Hours: 2, 1

Specific Objectives:

- Computational Fluid Dynamics Course provides an introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems.
- This course introduces the students to the finite difference and finite volume method as a means of solving different type of differential equations that arise in fluid dynamics.

Course Outline:

Introduction to Computational Fluid Dynamics, Problem solving strategy using CFD, Governing Equations of Fluid Flow, Discretisation of Governing equations, Finite difference method, Introduction to the Finite Volume Method , Numerical solution of governing equations, Solution analysis and accuracy, Introduction to advanced topics

Recommended Books:

1. Jiyuan Tu, Guan Heng Yeoh and Chaoqun LIU, Computational Fluid Dynamics: A Practical Approach, Butterworth-Heinemann/Elsevier.
2. J. D. Anderson, Jr., Computational Fluid Dynamics: The Basic with Applications, McGraw-Hill.
3. H. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Prentice Hall/Pearson.
4. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor & Francis.

Title of the Course: FLUID POWER: HYDRAULICS AND PNEUMATICS

Credit Hours: 2, 1

Specific Objectives:

- This course introduces the basic components and functions of hydraulic and pneumatic system.
- The objective is to understand the operation of a fluid power system with emphasis on the design and engineering of the system components

Course Outline:

Introduction to Fluid Power, Basic Principals of Hydraulics and pneumatics, Pumps, Hydraulic/pneumatic Circuits, Directional Control, Pressure Control, Hydraulic Flow Control, Ancillary Hydraulic Components.

Recommended Books:

1. Johnson, James L. Introduction to Fluid Power. McGraw-Hill.
2. Andrew Parr, Hydraulics and Pneumatics

Title of the Course: **GAS DYNAMICS**

Credit Hours: 3, 0

Specific Objectives:

- To understand the application of mechanics and thermodynamics to a variety of compressible fluid problems, both practical and theoretical.
- Emphasis is placed on understanding physical mechanisms and the use of computer simulations to understand unsteady compressible flows and pressure waves in fluids.

Course Outline:

Basic governing laws of conservation of mass, momentum and energy, limitations. Sub-sonic and supersonic gas flow. Mach number and Mach angle. Isentropic Flow and Applications; Operation of nozzles under varying pressure ratios. Normal and oblique shocks, Prandtl-Meyer compression and expansion with applications. Rayleigh flow and Fanno flow, Busemann's shock polar diagram.

Recommended Books:

1. Gas Dynamics, By M. J. Zucrow and J. D. Hoffman, Wiley. John Wiley & Sons, 1976
2. The Dynamics and Thermodynamics of Compressible Fluid Flow (Volume 1), 1st Edition By A. H. Shapiro, Ronald Wiley
3. Gas Dynamics, 2nd Edition By J. E. John, Allyn and Bacon.
4. Compressible Flow By B. W. Imrie

Title of the Course: **AERODYNAMICS**

Credit Hours: 3, 0

Specific Objectives:

- To understand the concepts in incompressible airfoil theory, including symmetric and cambered airfoils using analytical and numerical approaches.
- To understand the incompressible wing theory, including down wash, lifting-line theory, elliptic wings, general twisted wings, application of fundamentals to the design of a wing to meet given performance criteria.

Course Outline:

Introduction, aerodynamics of incompressible flow, compressible and ideal fluid flow, airfoils theory, finite wing aerodynamics, blade element theory and aircraft propellers, Cascade aerodynamics, jet propulsion, intake and nozzle performance, aircraft performance measurement.

Recommended Books:

1. Aerodynamics for Engineering Students, By El. Houghton & A. E. Brock St Mortin Cambridge University Press, 2003
2. Aerodynamics, By L. J. Clancy, Hallstead Pr.

MANAGEMENT ELECTIVE COURSES

Title of the Course: INDUSTRIAL MANAGEMENT

Credit Hours: 3, 0

Specific Objectives:

- Optimization of organizational resources
- To understand the tools/techniques related to Project Management
- To develop efficient relations with supplier and customers

Course Outline:

Plant management
Management systems Role & functions of management. Productivity, basic concepts, classification, measurement and improvement. Role of work study, work measurement and work sampling.

Facilities planning and design
Plant location, material handling systems, types of production, MRP-II, group technology, make or buy decisions, demand forecasting, material requirement planning, inventory models and just in time (JIT) technique, production planning, scheduling problems & models, project management, techniques for PERT & CPM, network scheduling, activity crashing and resource leveling.

Human resource management
Recruitment process, job evaluation, performance appraisal, non-financial and financial incentives, training, labour relations, management theories.

Recommended Books:

1. Production & Operations Management *By Evert E. Adam Jr and Ronald*. Prentice Hall
2. Production Management *By Kieth & Loekyer*.
3. Operations Management By Jay Heizer & Barry Render, Prentice Hall

Title of the Course: PROJECT MANAGEMENT

Credit Hours: 3, 0

Specific Objectives:

- To understand modern project management techniques related government regulations.
- To implement modern project management techniques using software.

Course Outline:

Fundamental principles, project proposals and feasibilities, project life cycle; project organization and human resource management; PM planning; Work breakdown structure; Estimating time and cost; Precedence relationships; Project scheduling and control techniques; Project risk analysis; Time compression and resource leveling; Computerized project management; special software packages

Recommended Books:

1. Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold Kerzner, John Wiley
2. Case studies in project management, 2nd Edition, by Harold Kerzner, John Wiley
3. Project Management Body of Knowledge (PMBOK) 4th Edition, by P. M.I.

Title of the Course: **OPERATIONS RESEARCH**

Credit Hours: 3, 0

Specific Objectives:

- To understand the Operations Research tools and techniques.
- To understand working and application of computer software packages.

Course Outline:

Operation Research Techniques and basics, Linear programming, graphical method, simplex method dynamic programming, sensitivity and post-optimal analysis, transportation models, Queuing theory (weighting live models). Replacement Models. Simulation. Basic principles, discrete models vs. continuous system simulation, Markov Chain.

Recommended Books:

1. Operations Research by H. A. Taha, Prentice Hall
2. Operation Management-Strategy and analysis by Krajewsky and Ritzman
3. Operations Research by S. Kalavathy, Vikas Publishing House.
4. Operations Research: Applications and Algorithms by Wayne L. Winston

Title of the Course: **TOTAL QUALITY MANAGEMENT**

Credit Hours: 3, 0

Specific Objectives:

- To understand the philosophy of total quality management
- To implement the tools and techniques in the organizations.

Course Outline:

Fundamental principles; Standards; Techniques for quality analysis and improvements; statistical methods and SPC. Acceptance sampling; QFD; Value engineering; Cross-functional management and benchmarking; ISO-9000 application, clauses, and implementation issues, Six Sigma.

Recommended Books:

1. Total Quality Management with text cases by John S. Oakland, Butterworth-Heinemann
2. Total Quality Management by Besterfields, Prentice Hall.
3. Statistical Quality Control by D.C. Montgomery.

Title of the Course: **OPERATIONS MANAGEMENT**

Credit Hours: 3, 0

Specific Objectives:

- To understand the philosophy of Operations management
- To implement the tools and techniques in the organizations.

Course Outline:

Basics of managing manufacturing and service organizations; strategic decision making; facility location and layout; job design and work compensation; demand forecasting; capacity and material planning; scheduling in various environments; emerging trends in managing operations. Use of quantitative management tools after introducing fundamental concepts.

Recommended Books:

1. Operations Management by Nigel Slack, Stuart Chambers and Robert Johnston.
2. Operation Management by Jay Heizer and Barry Render.

Title of the Course: **BUSINESS AND ENTREPRENEURSHIP**

Credit Hours: 3, 0

Specific Objectives:

- To understand the philosophy of Business and Entrepreneurship
- To implement the tools and techniques in the organizations.

Course Outline:

Evolution of the concept of entrepreneur, Characteristics of an entrepreneur, Distinction between an entrepreneur and a Manager, in Economic Development, Factors affecting entrepreneurial growth (economic, Non-Economic and Government factors)

Critical factors for stalling a new enterprise. Ingredients for a successful new business. Self-assessment and feedback, Personal entrepreneurial competencies. Goal setting.
Creativity and sources of new business ideas, the difference the difference between ideas and opportunity and creativity. Assessing business opportunities in Pakistan. Screening and evaluating opportunities Product planning and development process. Creating parallel competition by developing a similar product or service, Product life cycle, Finding sponsorship. Acquiring a going concern, E-Commerce and business start-up and growth.

Marketing as a philosophy, marketing management: Creating a marketing plan, Analyzing the environmental situation and the market opportunity, Setting marketing objective, Formulating a marketing strategy.

The business plan as selling document, reasons for writing a business plan your company: What's your identity, Field work started, Marketing issues: Who are your buyers?., Product issues: What are you selling?, Production exercise, Sales and Promotion: Financial issues: Targeting and writing the plan: Business Plan compilation exercise.

Franchising, becoming a franchisees versus starting a stand-alone business, the franchisee contract, Non-contractual considerations of buying a franchise, Limitations of franchising.

Recommended Books:

1. Rober D. Hisrich and Michael P. Peter, Entrepreneurs/lip,**5th Edition**, McGraw-Hill
2. S. S. Khanka, Entrepreneurial Development
3. Irving Burstiner, the small Businesses Handbook
4. Bruce A. Kirchhoff, Entrepreneurship and Dynamic Capitalism
5. Modern Business Management, A System & Environment Approach by McGraw-Hill
6. William D. Bygrave, The Portable MBA in Entrepreneurs/lip Entrepreneurship CEFE, Germany, Development Manual

Title of the Course: SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT

Credit Hours: 3, 0

Specific Objectives:

- To understand the philosophy of Safety Health and Environment
- To implement the concepts in the organizations.

Course Outline:

Introduction of Health and Safety, Industrial Safety: introduction objectives of Safety, Importance of Safety in an industry, Industrial accidents, Effects of accidents, Types of accidents incidence of fire. Fire prevention and control.

Principles of accident prevention, hazard analysis. Legal, humanitarian and economic reason for action. Safety inspection procedures. Safety training, First aid and emergency procedures,.

Introduction: importance of clean environment, Scale of Environmental Pollution. Environmental Act. Health and Safety Act.

Atmospheric Pollution: Types of Atmospheric pollution, Their Causes and Effects on Human Health, Available Technologies for Controlling Pollution.
Industrial Waste: Solid Waste, Industrial Effluents and Waste Gases, waste treatment plants.

Noise Pollution: Measurement of Noise level, Effect of excessive noise on human health. Remedial Measures.
ISO Standards for Safety and Health and Environment

Recommended Books:

1. Safety at Works **4th Edition** By John Ridley, Butter Worths Publishers
2. Factory & Production Management By K. G. Lockyer, Pitman Publishing

For MSc/MS/ME in Mechanical Engineering the minimum credit hours earned by a student shall be thirty (30) as per the distribution given below:

- Minimum number of credit hours: 30
  - Minimum number of credit hours for coursework: 24
  - Minimum number of credit hours for research: 06

The minimum number of 24 credit hours requirement for coursework is distributed as follows:

  - Minimum number of credit hours for core courses: 18
  - Minimum number of credit hours for elective courses: 06

The minimum number of courses in Master Programme shall be eight (8) distributed as follows:

- Minimum number of courses : 8
  - Minimum number of core courses: 6
  - Minimum number of elective courses: 2

The six (6) core courses shall be taken from the area of specialization of the student. However, the elective courses may be taken from another discipline or department of the University subject to proper justification by the student as well as approval by the Chairman of the respective department.

Special Topic
A subject of 3-credit hours can be offered by Universities / Institutions depending upon the expertise and needs.

Lists of Core Courses and Elective Courses
The courses for MSc/MS/ME are provided, however, the lists of core courses and elective courses shall be prepared by the respective Board of Studies of the Universities / Institutions as per procedures listed in their charters.

Specializations
Individual universities / institutions may design specializations in Mechanical Engineering keeping in consideration the demand and availability of faculty and facilities. The curriculum / syllabus shall be approved by the individual universities / institutions as per procedures listed in their charters.

Proposed Courses for MSc/MS/ME in Mechanical Engineering

The courses for MSc/MS/ME programme in Mechanical Engineering are provided below. However, apart from these courses, individual universities / institutions may design courses keeping in consideration the demand and availability of faculty and facilities. The course contents / syllabus shall be approved by the individual universities / institutions as per procedures listed in their charters.

Title of the Course: ADVANCED NUMERICAL ANALYSIS

Credit Hours: 3, 0

Specific Objectives:

- To integrate a discussion of the properties of engineering and physical problems with the discussion of methods by which such problems may be solved numerically
- To provide understanding of main sources of numerical errors and the power of numerical methods that minimize these errors

Course Outline:

Introduction: basic ideas, concepts, terminology, elements of a numerical method: differential formulation, solution domain and mesh, discretization, set of algebraic equations, solution algorithm.

Preview: choice of numerical mesh, Cartesian, polar-cylindrical, general orthogonal, regular non-orthogonal, arbitrary triangular meshes, discretization, truncation and discretization errors, Newton's method of solving algebraic equation of single variable, Crammer's rule for solving set of equations, round off errors and their estimation.

Polynomials and Finite differences: collocation-type polynomials, finite-difference-operator algebra, forms of polynomials, relationship to Taylor series.
Finite differences: differences and Differential operators, basic operator relations, relations of first, second and higher order derivatives to difference series, solutions errors.

Solution of equation sets: Ill-conditioning, iterative solution methods, Decomposition, Eigen-value problem, system stability, characteristic polynomial, roots, Eigen-values, convergence of solution scheme.
Ordinary differential equations: order, methods of solving first order ordinary differential equations, higher order differential equations and their conversion into set of first order ordinary equations.

Partial differential equations: variants of partial differential equation, choice of finite-difference formulation and solution algorithm, elliptic, parabolic and hyperbolic equations. Discretization and solution of second order 2-D steady diffusion equation, first order 1-D transient diffusion equation, first order 1-D convection equation, Finite volume approach

Recommended Books:

1. Numerical Analysis by Richard L. Burden, John Douglas Faires, 9th Edition, Cengage Learning, 2010, ISBN: 0538733519, 9780538733519.
2. Applied Numerical Analysis by Curtis F. Gerald, Patrick O. Wheatley, 7th Edition (August 10, 2003), Pearson, ISBN-10: 0321133048, ISBN-13: 978-0321133045.

Title of the Course: ADVANCED ENGINEERING MATERIALS

Credit Hours: 3, 0

Specific Objectives:

- To be able to perform design using advanced materials and carry out research on mechanical properties of these materials.
- To provide students with the latest developments in material technology and applications of new advanced materials.

Course Outline:

Polymeric Material: High performance fiber, high performance elastomers, high performance coatings, special polymers, moderately high polymers, engineering polymers. Materials development and modification, multilayer and adhesive technology will also be part of this course. Physical and chemical testing of polymers.

Fundamentals of polymers: Molecular structure, polymerization processes, morphology of polymer molecules, plasticizers and fillers. Composition and characteristics of principal types of polymers, convention constant rate of elongation test, creep tests, isochronous curves and other forms of data presentation, strain recovery and stress relaxation, anisotropy of properties time-dependence of strength and creep rupture, durability under cyclic loading BS impact tests.

Fracture of polymers: Fundamentals of fracture mechanics, application of fracture mechanics to polymers, Kc determinations Kc crack speed curves instability, environmental effects impact testing, application to practical problems.

Composites: Composite materials compared with conventional materials, fiber and matrices, composite mechanics, elastic properties, failure processes, failure at notches, notch sensitivity and fracture energy. Fatigue and failure of composite materials. Deterioration of properties owing to environmental conditions, hybrid composite materials, manufacturing the by hand lay-up, preparing specimen for mechanical testing, burn off tests to determine fibre volume fracture.

Categories of composites. Properties of glass and other fibers. Matrix materials composites as monotropic membranes. Mathematical models of stiffness of composites based on mechanics of materials and energy considerations. Elasticity of anisotropic materials. Strength of composites. Outline of methods of manufacturing composites and of their application.

Recommended Books:

1. Polymeric Materials: Structure, Properties, Applications by G. W. Ehrenstein, Hanser Verlag, 2001, ISBN: 1569903107, 9781569903100.

2. Composite Materials: Fatigue and Fracture, edited by Ronald B. Bucinell, 7th Volume, ASTM International, 1998, ISBN: 0803126093, 9780803126091.

3. Composite Materials: Science and Engineering by Krishan Kumar Chawla, Springer, 1987, ISBN: 0387984097, 9780387984094.

Title of the Course: ADVANCED CAD/CAM

Credit Hours: 3, 0

Specific Objectives:

- To develop understanding of the principles underlying computer aided tools used in engineering
- To develop students' awareness in the application of CAD and CAM systems in the context of developing engineering products

Course Outline:

Overview of existing CAE systems. Fundamental of CAD: Introduction, Design Process, Creating manufacturing database. CAD/CAM System Hardware Structure, Configuration, Mini, Micro, Interactive display devices, Peripherals, Storage, Display and operating system.

Geometric Modal and Technique, Solid Modeling, Graphics in CAD.
Conventional numerical control, NC part programming, computer numerical control, NC programming with interactive graphics, The role of group technology in CAD/CAM, The role of process planning in CAD/CAM, Process planning system.

Recommended Books:

1. V. B. Anand: Computer Graphics and Geometric Modeling for Engineers, John Wiley and Sons, 1993.
2. H. B. Kief and T. F. Waters: "Computer Numerical Control", A CNC Reference Guide, GLECOE, discovery. McGraw-Hill, 1992.

Title of the Course: FINITE ELEMENT ANALYSIS

Credit Hours: 3, 0

Specific Objectives:

- To develop comprehensive knowledge in the fundamental mathematical and physical basis of finite element method (FEM).
- To develop complete FEM solution strategy for analysis of mechanical/thermo-mechanical systems.

Course Outline:

The stiffness method and the plane truss, Integral formulations and variational methods, week boundary value problem, Rayleigh – Ritz method, numerical error and accuracy analysis, Eigen value problem, Two and three Dimensional problems, Plane Elasticity, Bending of plates, beams, nonlinearity sources (material and geometric), techniques for nonlinear analysis, Basic Equations of Thermal Analysis, FEs for thermal analysis, Thermal transients, use of commercial FEA codes. Applications of FEA in the relevant fields of study.

Recommended Books:

1. Introduction to Finite Element Method by Frank Stasa, CBS.
2. Finite Element Procedures by Bathe, Prentice Hall.
3. ANSYS Manuals, ANSYS Publication.

Title of the Course: **COMPUTER INTEGRATED MANUFACTURING**

Credit Hours: 3, 0

Specific Objectives:

- To develop the concepts of Computer Integrated Manufacturing, Flexible Manufacturing System and automated flow
- To develop understanding of classical and state-of-the-art production systems, control systems, management technology, cost systems, and evaluation techniques

Course Outline:

Fundamental of operations and automation strategies, High volume production systems, computer aided manufacturing, numerical Control of Production Systems, Industrial Robots, Material Handling and Storage, Group Technology, Flexible Manufacturing Systems, Quality Control and Automated Inspection, Expert Systems.

Manufacturing Systems:
Introduction, Overview of manufacturing processes, Machine tool and manufacturing equipment, process planning, design of manufacturing system, operation of manufacturing systems.

Recommended Books:

Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice Hall, 2007.

Title of the Course: THEORY OF ELASTICITY

Credit Hours: 3, 0

Specific Objectives:

- To develop concepts related to theory of elasticity and methods of solving the problems.
- To apply the methods of theory of elasticity in technical calculations on the basis of illustrative examples.

Course Outline:

Cartesian Tensor Analysis, 3D state of stress and stress transformation, Principal stresses and planes. Mohr's Representation, Stress small deformation theory, Strain displacement relations, Strain compatibility equations. Stress-Strain relation, Lame's and engineering constants. Formulating of problem in elasticity, Bi-harmonic equation, Stress function. Plane stress and plane strain problem in Cartesian and polar coordinates. Principle of superposition, Uniqueness of elasticity solution, Axisymmertic plane problems. Semi inverse method. General solution of torsion problem. Solution derived from equations of boundaries. Approximate solution of torsion of cell sections, Review of the equations of the theory of elasticity

Recommended Books:

1. Theory of Elasticity by S. P. Timoshenko and Goodier, McGraw- Hill.
2. Elasticity, Tensor and Dyadic Approach by Pe-Chi-Chou, John Wiley.
3. Advance Mechanics of Material by Hugh Ford, McGraw-Hill.

Title of the Course: EXPERIMENTAL STRESS ANALYSIS

Credit Hours: 3, 0

Specific Objectives:

- To learn the basics of commonly used Experimental Stress analysis techniques.
- To train students in the modern methods of measuring strains (stresses), displacements, etc.

Course Outline:

Revision of Fundamental concepts of stress and strain in two and three dimensional. Mechanical and electrical gauges. Electrical resistance strain gage material, Foil and wire gages, Two and three elements rosette, Cross sensitivity factor, Potentiometer and Wheatstone bridge circuit, Full-half and quarter bridge circuit, Strain indicators, Data acquisition systems, Transducers. Optics description of light as an electromagnetic wave. Maxwell's equations. Design of optical elements. Wave plates. Theory of diffraction of light, Stress optic law, Photo-elasticity. Caustics. Stress Freezing, Scattered ray and brittle coating techniques. Grid methods. Brittle coatings. Laser interferometry. Moire interferometry. Normal and transverse displacement interferometers. Mechanical testing of ductile and brittle materials. Quasi-static loading, Dynamic loading.

Recommended Books:

1. Experimental Stress Analysis by J. W. Dally and W. F. Riley.
2. Handbook on Experimental Mechanics. Edited by Albert S. Kobayashi.

Title of the Course: PRODUCT DESIGN AND DEVELOPMENT

Credit Hours: 3, 0

Specific Objectives:

- To learn methods of reducing development costs and time necessary for commercialization.
- To enable students to co-ordinate and schedule the activities involved in the design and development of products within the entire set of activities, taking into account time, tasks, resources and manufacturing.

Course Outline:

Design process, advanced technology for design process, idea generation and creative problem solving, Project-centered subject addressing transformation of new ideas into technology based products, attaining a proper match between product and marketplace. Product design specification, Product design issues: evaluation, market perception, aesthetics and human interfacing, Design for manufacturability, reliability, and repair ability, pricing and legal implications.

Recommended Books:

1. CAD/CAM by McMohen & Brownie.
2. Product Design & Development by Ulrich Eppinger
3. Total Design by Pugh.

Title of the Course: ADVANCED MECHANICAL VIBRATIONS

Credit Hours: 3, 0

Specific Objectives:

- To learn application of analytical and computational methods for machine design and vibration control problems.
- To enable students in conducting basic vibration analysis of systems with a large number of degrees of freedom.

Course Outline:

Properties of vibrating system, Lagrange's equation. Continuous systems: Transverse vibration of string of cable, longitudinal. Use of computers for solution of vibration problems. Orthogonality of Eigen vectors, modal matrix, normal mode summation, computational methods, Gauss elimination, matrix iteration to the Finite Element Method, mode summation procedures for continuous systems, random vibrations, non-linear vibrations, perturbation method, phase plan, modal analysis.

Recommended Books:

1. Mechanical Vibrations, S. S. Rao, Prentice Hall, 5th edition.
2. Theory of Vibration with Applications, W. T. Thomson, Prentice Hall, 5th edition.
3. Fundamentals of Mechanical Vibrations, S. G. Kelly, McGraw-Hill, 2nd edition.

Title of the Course: **ENGINEERING DESIGN OPTIMIZATION**

Credit Hours: 3, 0

Specific Objectives:

- To provide knowledge about traditional optimization techniques and newer techniques for multidisciplinary optimization.
- To develop ability for proper engineering optimization problem statement and select which method is appropriate for a given application.

Course Outline:

Modeling. Mathematical modal. Nature of design process. Analysis and design models. Optimal design. Formal optimization model. Bounded ness, Feasibility and constraint activity. Topography of the design space. Mathematical review. Notation. Multi-variable functions. Continuity gradient and definite matrices. Convergence of algorithms. Conditions of optimality: necessary and sufficient conditions for unconstrained and constrained optima. Meeting of LaGrange multipliers. Methods of unconstrained optima. One dimensional minimization. Bisection and golden section initial bracketing, Polynomial interpolation. Multi-dimensional minimization. Steepest descent. Conjugate direction & conjugate gradient methods. Newton's method and its modifications. Quasi-Newton methods. Scaling. Stopping criteria. Methods for constrained optima. Interior and exterior penalty method. Augmented lagrangian method. Direct methods.

Recommended Books:

1. Principles of Optimal Design by Papalambros & Press, USA. Wilde, McGraw-Hill
2. Introduction To Optimum Design by J. Arora,

Title of the Course: ROBOTICS

Credit Hours: 3, 0

Specific Objectives:

- To familiarize the students with the concepts and techniques in robot manipulator control, to incorporate robots in engineering systems.
- To impart fundamentals of manipulators, sensors, actuators, end effectors and product design for automation.

Course Outline:

An overview of Robotics, Drive methods, Sensors for robots. Spatial description and transformation, Forward kinematics Inverse Kinematics Jacobean, Denavit-Hartenherg coordinate transformations, Force/Torque relations, Trajectory planning, Dynamics, Lagrange equations, Position control, PID control, Inverse dynamics feed forward control, Nonlinear and two parts control. open-Loop Manipulators, Closed Loop Linkages, Epicyclical Gear Drives, Wrist Mechanisms, Tendon Driven Robotics Hands. Robot Sensors including contact sensors and proximity sensors, Machine vision systems Robotics application growth and cost.

Recommended Books:

1. Robotics: Modelling, Planning and Control
   Advanced Textbooks in Control and Signal Processing, by Lorenzo Sciavicco, Springer, 2009, ISSN 1439-2232, ISBN: 1846286417, 9781846286414.

2. Springer Handbook of Robotics *Gale virtual reference library, edited by* Bruno Siciliano, Oussama Khatib, Springer, 2008, ISBN: 354023957X, 9783540239574.

3. Introduction to Robotics: Mechanics and Control By John J. Craig, Prentice Hall; 3rd Edition (August 6, 2004), ISBN-10: 0201543613, ISBN-13: 978-0201543612.

Title of the Course: ADVANCED THERMODYNAMICS

Credit Hours: 3, 0

Specific Objectives:

- Development of equations of state and thermodynamic property relations.
- Enabling students to perform multi-component and multiphase system analysis.

Course Outline:

Equilibrium of thermodynamics systems: concept of equilibrium, spontaneous change, criterion of stability, equilibrium of system, Van der Waals' equation.
Systems of constant chemical composition: thermodynamic properties, equation of state, law of corresponding states, relations for pure substance, applications, specific heats, Clausius–Clapeyron equation, liquefaction of gases.
Ideal gases and ideal gas mixtures of constant composition: state of all ideal gases, internal energy and enthalpy of an ideal gas, entropy of an ideal gas-the third law of thermodynamics, Gibbs free energy equation, heats of reaction or calorific values, adiabatic combustion, heats of formation and Hess's law, entropy of ideal gas mixtures.

Gas mixtures of variable composition: chemical potential, stoichiometry and dissociation, chemical equilibrium, equilibrium constant and heat of reaction, Van't Hoff's equation, calculations, temperature rise due combustion reaction, Lighthill ideal dissociating gas, ionization of monatomic gases, non-equilibrium processes, equilibrium and frozen flows.

Special systems: application of thermodynamics to elastic systems, systems with surface tension, reversible cell, fuel cell, magnetic systems, steady state or irreversible thermodynamics, thermo-electricity.

Recommended Books:

1. Advanced Thermodynamics *Mercury Learning Series, by* Scott Post, Mercury Learning & Information, 2013, ISBN: 1936420279, 9781936420278.

2. Advanced thermodynamics for engineers, by D. E. Winterbone, Arnold, 1997, ISBN: 047023718X, 9780470237182.

3. Advanced Engineering Thermodynamics, 3rd Edition, Adrian Bejan, August 2006, ISBN: 978-0-471-67763-5.

Title of the Course: ADVANCED FLUID MECHANICS

Credit Hours: 3, 0

Specific Objectives:

- To train students to identify, formulate and solve engineering problems concerning internal and external flows.

- To formulate the boundary layer problems and momentum integral equation and to obtain the exact solutions or the approximate solutions of the momentum equation.

Course Outline:

Fluid Dynamics: Laminar and turbulent boundary layer flow with and without heat transfer, boundary layer separation stability transition and control.
Kinematics and dynamics of flow of continuous media, Navier-Stokes equation, simplification, exact and approximate solution. Irrational of hydrodynamics stability, turbulence, free shear flows, chemical reactions, and shock expansion.

Rotating Fluid Machinery: Aero dynamics of compressors & turbines, subsonic, transonic and supersonic flow characteristics, secondary flow and stall stability, components matching of total non-dimensional representation of performance.

Recommended Books:

1. Advanced Fluid Mechanics, by William Graebel, Academic Press; 1st edition (July 5, 2007), ISBN-10: 0123708850, ISBN-13: 978-0123708854.

2. Advanced Engineering Fluid Mechanics by K. Muralidhar, Gautam Biswas, 2nd edition, reprint, Alpha Science International, 2005, ISBN:184265134X, 9781842651346.

3. Advanced Fluid Mechanics: An Introduction by Arved Jaan Raudkivi, Robert A. Callander, John Wiley & Sons, Incorporated, ISBN: 0470709405, 9780470709405.

Title of the Course: ADVANCED HEAT TRANSFER

Credit Hours: 3, 0

Specific Objectives:

- To demonstrate and in-depth understanding of fundamental heat transfer principles
- To develop analytic solutions of simplified heat transfer problems

Course Outline:

Conduction: Review of analytical methods in heat conduction, melting and freezing, sources and sinks, anisotropic and composites media, numerical methods for steady and unsteady state problems. Numerical methods for solution of steady and unsteady state conduction problems.

Convection: Analysis of isothermal and non-isothermal boundary layers. Exact and approximate solution of laminar and turbulent flow, variable property and high speed effect, the dimensional analysis. Navier-Stokes equations numerical

solutions by velocity and temperature fields in boundary layers of simple and complex shapes.

Radiation Heat Transfer: Radiation properties; black body radiation, shape factor of radiations, network analogy, and solar radiation.

Recommended Books:

1. Heat Transfer: Textbook by John H. Lienhard.
2. Heat and Mass Transfer, by Frank P. Incropera.

Title of the Course: **EXPERIMENTAL METHODS IN FLUID MECHANICS**

Credit Hours: 3, 0

Specific Objectives:

- To introduce students to a selection of currently used experimental methods for measuring fluid flows.
- To expose the student to the limitations of experimental measurement systems and the validity of the produced data.
- To introduce the importance of estimating and reporting uncertainty levels in experimental data

Course Outline:

Instruments for measurement in fluid flow: monitoring and controlling processes, engineering analysis, categories of flow, instrumentation in thermo-fluids, planning, designing and carrying out experiments, stages of an experimental investigation.

Pressure differential devices: incompressible and compressible flow cases, idealized analysis of flow meters, practical flowmeters, Rota meter, idealized analysis, use with gases, calibration.

Turbulence and Reynolds number: 2-D nozzle jet flow, time-dependent flow, coordinates and notation of the actual, mean and fluctuating components of flow velocity, time-averaged quantities, case studies.

Pressure measurements: measurement at wall, manometers and instruments, pressure transducers, Pitot tubes (probes) performance, error sources, Pitot-static tubes performance.

Flow system: open and closed circuit wind tunnels, high-pressure and /high-temperature closed circuit wind tunnels, working section, use of screens, meshes, gauzes, course meshes, honeycombs, nozzles, diffusers, contractions, bell-mouth contractions, refracting meshes, splitter plates, guide vans, blowing (Coanda effect), boundary layer suction, corners, corner vanes.

Hot wire anemometry (HWA): measurement of mean and fluctuating components of velocity, HW response, King's law, Constant current (CCA) and constant temperature anemometers (CTA), calibration procedures, directional characteristics, normal yawed and crossed wires, processing the hotwire signals. Hot film anemometry, HWA versus HFA.

Laser Doppler Anemometry (LDA): basic Doppler effect, laser light properties, components of LDA system, general schematic of an LDA system, 2-beam LDA system, signal processing, counters and trackers, Bragg cell, forward and backward LDA, choice between LDA, HWA and HFA.
Transducers: strain gauge, Piezo-electric, diaphragm pressure transducers, measurement of mechanical displacement, velocity, acceleration, rotational speed.

Combustion flow measurements: measurement of temperature, pressure, velocity, density, pollutants, NO_x, SO_x, HO_x, HC, and fuel concentrations,
Particle sizing: mean droplet size, size distribution of droplets, droplet velocities, and trajectories, mean droplet diameters, non-intrusive techniques, spark photography, light scattering- laser diffraction, single particle counting, soot particles.

High-speed cine film photography, holography, use of digital camera for experimentation and flow visualization in thermo-fluids.

Recommended Books:

1. Springer Handbook of Experimental Fluid Mechanics, Volume 1, edited by Cameron Tropea, Alexander L. Yarin, John F. Foss, Springer, 2007, ISBN: 3540251413, 9783540251415.

2. Hot Wire Anemometry: Principles and Signal Analysis
   Oxford science publications, by H. H. Bruun, edition: illustrated, reprint, Oxford University Press, 1995, ISBN: 0198563426, 9780198563426.

3. Fluid Mechanics Measurements, by R. Goldstein, Publisher: CRC Press; 2nd edition (March 1, 1996), ISBN-10: 156032306X, ISBN-13: 978-1560323068.

Title of the Course: OPERATIONS RESEARCH

Credit Hours: 3, 0

Specific Objectives:

- To introduce the methods of Operations Research
- To relate the course material to research activities

Course Outline:

Linear Programming: Formulation, Graphic solution, Assumptions of LP, the simplex method, Equality constraints, Inequality constraints, Negative RHS, Duality theory, Primal and dual problem.

Special types of LP problems: The transportation problem, Production scheduling, North-west corner rule, Vogel's approximation method, Russell's method, Transshipment problem, Assignment problem, Goal programming, Sensitivity analysis, Parametric programming, Dynamic programming, integer Programming.

Queuing Theory: Basic queuing process, the birth and death process, Basic model with infinite and finite queue, Limited input source, Priority Queuing model.

Inventory Control Theory: Deterministic Model: Continuous review uniform demand, shortages permitted, quantity discount – shortages not permitted.
Stochastic Model: Single – period model with no setup cost, Model with initial stock level, Single – period model with setup cost, Two – period inventory model with no setup cost.

Recommended Books:

1. Operations Research by R. Panneersel Vam, 2nd Edition, PHI Learning Pvt. Ltd., 2006, ISBN: 8120329287, 9788120329287.

2. Operations research: Applications and algorithms by Wayne L. Winston, Jeffrey B. Goldberg, 4th Edition, Thomson Brooks/Cole, 2004.

Title of the Course: ADVANCED METAL FORMING

Credit Hours: 3, 0

Specific Objectives:

- To provide student with the understanding of mechanics & various materials widely used in metal forming processes.
- To develop ability evaluating the basic design methodologies for metal forming contents.

Course Outline:

Macroscopic Plasticity & Yield Criteria: Tresca, & Von Mises criterion; Plastic work, Effective stress; Effective strain; Flow rules for plastic stress – strain relations; Principle of normality.

Work hardening & Plastic instability: Tensile test; Mechanical properties; Nominal and true stress-strain curves; work hardening expression; Behavior after necking; Direct compression; Bulge test; Plane-strain compression test. General approach to instability; Balanced biaxial tensin; Thin-walled sphere internal pressure; significance of instability.

Strain Rae and Temperature: Strain rate; Super plasticity; combined stress and strain-rate effects; Strain rate dependence; Temperature dependence of flow stress; Hot working; temperature rise during deformation.
Ideal Work: Ideal Work or uniform energy; Extrusion & rod drawing; Friction; Redundant work, and mechanical efficiency; Maximum drawing reduction.

Slab analysis: Sheet drawing; Comparison of slab method & ideal work method; wire drawing; Direct compression in plane strain; Average pressure during plane-strain compression; Sticking friction; Axisymmetric compression; Flat rolling.

Bending: Spring back in sheet bending; Bending with superimposed tension; Sheet bend ability; Bending of sheets & tubes; Forming limits in shape bending. Cupping, Redrawing, and Ironing Cup drawing; Effects of work hardening; Deformation efficiency; Effects of tooling; Redrawing; Ironing.

Complex Stamping: Localized necking in biaxial stretching; Formability; Formain limit diagrams; Cupping test; Edge cracking; Bulk forming tests.

Recommended Books:

1. Metal Forming Mechanics and Metallurgy by William F. Hosford and Robert M. Caddell.
2. Theory of Plasticity by J. Lubli
3. Mechanical Metallurgy by Dieter

Title of the Course: HUMAN FACTOR ENGINEERING

Credit Hours: 3, 0

Specific Objectives:

- To develop the ability of technologists to design systems that take advantage of what humans are good at.
- To provide a set of design principles that focus on the most important element in any system, that is the human

Course Outline:

Introduction: Scope of Ergonomics, Human operator as system components; physical size and shape dynamics, anthropometry, sources and application of energy input sensitivity, central processing capacity, input characteristics, environmental effects, heat and vibration, lightning and noise. Techniques in human factor studies; the assessment of physical activity, subjective assessment technique, methods of work analysis.

Design Requirements: Interface design; space requirements and layout visual presentation of information, auditing presentation of information, machine dynamics, control design, environmental factors, jobs aids, System evaluation.

Recommended Books:

1. Human Factors Engineering and Ergonomics: A Systems Approach by Stephen J. Guastello, Routledge, 2006, ISBN: 0805850066, 9780805850062.

2. Human factors in engineering and design McGraw-Hill psychology series by Mark S. Sanders, Ernest James McCormick, 7th edition, McGraw-Hill, 1993, ISBN: 007054901X, 9780070549012.

Title of the Course: **ADVANCED STRESS ANALYSIS**

Credit Hours: 3, 0

Specific Objectives:

- To provide a thorough understanding of advanced topics concerning the response of materials and structural elements to applied forces causing deformation.
- The course is expected to give a firm foundation to advanced design topics concerning stress analysis to provide solutions to complex problems

Course Outline:

Introduction: Analysis of stress and strain, Review of relation for various type of stresses, Equations of equilibrium, Boundary conditions and principal stresses. Generalized Hook's law, boundary value problems of linear elasticity.

Elasticity applications: Thick tube, Stress concentration due to a Circular hole in a stress plate, concentrated load acting on the vortex of a Wedge and Concentrated force acting on the free surface of a plate.

Elastic-plastic Structures: The occurrence of fracture and the inadequacies of conventional design concepts. Type of fractures that occur under uni-axial tensile loading. The physical significance of fracture toughness. The role of dislocations in plastic deformation of single and polycrystalline materials.

Contact ' Thermal Stresses: Application of Contact Stresses to mating of gear teeth, shaft in a bearing and ball and rollers in bearings. Thermal stresses and thermal strains; applications to turbines and pipes carrying hot fluids.

Viscoelasticity Analysis: Type of time dependence superposition, Boltzmann's integral, Differential form, in phase and out of phase components. Laplace transforms and relationship between viscoelastic parameters. Model materials, Maxwell Voigt and standard linear solid.
Photo elasticity.

Plasticity: Plane strain deformation and slip line field. Stress distribution from the slip line field. Upper bound and lower bound theorem.

Recommended Books:

1. Advanced Mechanics of Materials and Applied Elasticity, Fifth Edition by: Ansel C. Ugural; Saul K. Fenster, Prentice Hall, June 21, 2011, ISBN-10: 0-13-707920-6, ISBN-13: 978-0-13-707920-9.

2. Theory of Viscoelasticity by Richard M. Christensen, 2nd Edition, Dover Publications, 2003, ISBN: 048642880X, 9780486428802.

3. Fundamentals of the theory of Plasticity by L. M. Kachanov, Courier Dover Publications, 2004, 0486435830, 9780486435831.

Title of the Course: **MODAL ANALYSIS**

Credit Hours: 3, 0

Specific Objectives:

- To give an understanding of Modal Testing, its possibilities, limitations and to perform proper mobility measurements as the basis for modal analysis
- To explain and demonstrate how to plan and execute a complete modal test and to perform modal analysis on real structures

Course Outline:

Introduction, Application and philosophy of modal testing, Summary of theory, Measurement methods, Analysis and test procedures, Introduction to mobility measurement techniques, Basis measurement system structure preparation, Excitation of structure, Transducer and amplifiers, Analyzers, Digital signal processing, Use of different excitation types, Calibration, Mass cancellation, Rotational mobility measurement, Measurement on non-linear structure, Multi excitation methods, Introduction to model parameters extraction methods, Preliminary checks of PRF data, SDOF modal analysis, I peak amplitude, SDOF modal analysis-II, Circle fit method, SDOF Modal analysis-III inverse method, MDOF curve-fitting procedures, MDOF curve –fitting in the same domain, Global or multi curve-fitting, Non-linear systems. Introduction to derivation mathematical models, modal models, Display of modal model, Response models, Spatial models, Mobility skeletons and system models. Applications, comparison of experiment and

prediction, correction of adjustment of models, Structure modifications; Coupled structure analysis, Response prediction modifications, Coupled structure analysis, Response prediction and force determination.

Recommended Books:

1. Modal Analysis By D. J. Ewins, Wiley.
2. Modal Testing, Theory and Practice By D. J. Ewins, Wiley.

Title of the Course: CONTINUUM MECHANICS

Credit Hours: 3, 0

Specific Objectives:

- Demonstrate knowledge of the physical meanings, principles, and mathematics of continuous media represented as solids, liquids, and gases.
- Articulate basic principles and equations applicable to all constitutive models and their applicability limits of continuum mechanics

Course Outline:

Introduction, basic assumptions, vectors and tensors, tensor analysis, state of stress, kinematics of deformation. General principles of mechanics and thermomechanics. Constitutive equations of large-deformation elasticity, , development of mathematical tools, Kinematics of a continuum stresses general principles. Theory of constitutive equations. Basic material laws. Curvilinear coordinate systems in tensors.

Recommended Books:

1. Introduction to the Mechanics of a Continuous Medium L. E. Malvern Prentice Hall.
2. Continuum Mechanics by A. J. M. Spencer, Longman.

Title of the Course: TOTAL QUALITY MANAGEMENT

Credit Hours: 3, 0

Specific Objectives:

- The course aims to impart knowledge on the quality management process and key quality management activities
- Demonstrate how to design quality into product and services, describe the importance of developing a strategic plan for Total Quality Management

Course Outline:

Introduction to TQM, ISO-9000 Quality Model, Quality in manufacturing and service, Principles of total quality management, Leadership and Strategic planning, A focus on the customer, Quality measurement, Method for continuous improvement, Participation and teamwork, Implementation issue and strategies, inspection & quality control. Control Charts and their applications. Economics & quality control, Life testing, reliability, reliability prediction and calculations, reliability enhancing techniques.

Recommended Books:

1. Total Quality Management by James R. Evans, American Management Assoc.
2. Total Quality Management by Johns Ornland Amriu S. Soha, Pacific Rim.