CURRICULUM

OF

ENERGY SYSTEMS ENGINEERING
BS/BSc/BE/MS/ME

Revised 2014

HIGHER EDUCATION COMMISSION
ISLAMABAD

CONTENTS

CURRICULUM DIVISION, HEC

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Mr. Fida Hussain	Director General (Acad)
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PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

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

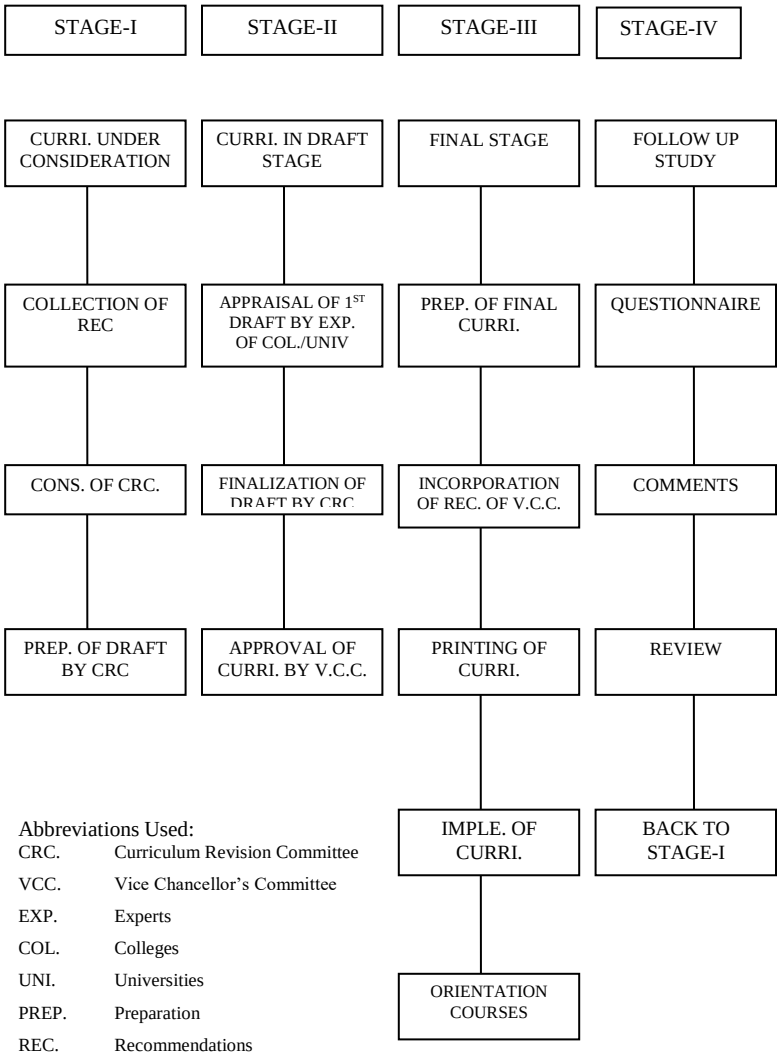
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector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

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

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

(Fida Hussain)
Director General (Academics)

CURRICULUM DEVELOPMENT PROCESS



Abbreviations Used:

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

MINUTES OF FINAL MEETING OF NCRC IN DISCIPLINE OF ENERGY SYSTEMS ENGINEERING HELD ON SEPT, 29 TO OCT 01, 2014 AT HEC REGINIONAL CENTER, LAHORE

The final meeting of National Curriculum Revision Committee in the discipline of Energy Systems Engineering was held on Sept 29 to Oct 01, 2014 at HEC Regional Center, Lahore. The purpose of the meeting was to finalize the draft curriculum of Energy Systems Engineering at undergraduate level. Following Members attended the meeting:

S. No.	Name	Designation
1.	Prof. Dr. Zahid Mahmood, Dean, University of Engineering & Technology, Peshawar, KPK	Convener
2.	Prof. Dr. Muhammad Iqbal, Dean, Faculty of Agri. Engineering & Technology, University of Agriculture, Faisalabad	Co-Convener
3.	Prof. Dr. Manzoor Ahmad, Department of Farm Machinery & Power, Faculty of Agri. Engg. & Technology, University of Agriculture, Faisalabad.	Member
4.	Prof. Dr. Muhammad Usman Keerio, Dean, Faculty of Electrical Engineering, Quaid-e-Awam University of Engg, Science & Tech., Nawabshah, Sindh.	Member
5.	Prof. Dr. Abdul Sattar Larak, Chairman, Department of Electrical Engineering, Mehran University of Engineering & Technology, Jamshoro, Sindh.	Member
6.	Dr. Nadeem Amjad, Chief Scientist/Member, Pakistan Agriculture Research Council, Islamabad.	Member
7.	Prof. Dr. Ahmad Shafi, Department of Mechanical Engineering,	Member

S. No.	Name	Designation
	NFC, Institute of Engg. & Fertilizer Research, Faisalabad.	
8.	Dr. Munir Ahmad, Chief Scientist/ Secretary, (Expert in Renewable Energy), Pakistan Agriculture Research Council, Islamabad.	Member
9.	Prof. Dr. J. K. Sial, In-Charge, Faculty of Agri. Engg. & Technology, PMAS, Arid Agriculture University, Murree Road, Rawalpindi.	Member
10.	Prof. Dr. Muhammad Yasin, Faculty of Agri. Engg. & Technology, PMAS, Arid Agriculture University, Murree Road, Rawalpindi.	Member
11.	Prof. Dr. Maqsood Ahmad, Department of Environmental Management & Policy, Balochistan University of Information Technology, Engineering & Management Sciences (BUITEMS), Quetta.	Member
12.	Dr. Syed. Amjad Ahmad, Head of Department, Department of Mechanical Engineering, NFC, Institute of Engg. & Fertilizer Research, Faisalabad.	Member
13.	Prof. Dr. Daulat Khan, Department of Agricultural Engineering, University of Engineering & Technology, Peshawar, KPK.	Member
14.	Prof. Dr. Allah Bakhsh, Chairman, Department of Irrigation & Drainage, Faculty of Agriculture Engineering & Technology, University of Agriculture Faisalabad.	Member
15.	Mr. Khalid Islam Director General, Pakistan Council of Renewable Energy, Islamabad.	Member

S. No.	Name	Designation
16.	Engr. Samiullah Shaikh, Dy. Director, PCRET, Lahore in place of Mr. Khalid Islam, Pakistan Council of Renewable Energy, Islamabad.	Member
17.	Dr. Tanveer Hussain Professor, Department of Mechanical Engineering, Mehran University of Engineering & Technology, Jamshoro	Member
18.	Engr. Muhammad Azhar Ali, Lecturer, Department of Structures & Environmental Engineering, University of Agriculture, Faisalabad	Member
19.	Dr. Zubair S. Khan HoD, Center of Energy Systems for NUST, Islamabad	Member
20.	Dr. Abdur Rashid, Department of Electrical Engineering COMSATS Institute of Information Technology, Abbottabad	Member
21.	Dr. Muhammad Azam khan, Chairman, Department of Food Engineering, Faculty of Agricultural Engineering & Technology, University of Agriculture, Faisalabad.	Member
22.	Dr. Abdul Ghafoor, Department of Farm Machinery & Power, Faculty of Agricultural Engineering & Technology, University of Agriculture, Faisalabad.	Member
23.	Mr. Abdullah Mengal Assistant Professor, Department of Mechanical Engineering Balochistan UET, Khuzdar	Member
24.	Engr. Prof. Dr. Nasrullah Khan, Professor, Department of Electrical Engineering, COMSAT Institute of Information	Member

S. No.	Name	Designation
	Technology, Islamabad	
25.	Dr. Abdul Rashid Professor, COMSAT Institute of Information Technology, Abbottabad	Member
26.	Engr. Faiz hmad Bhutta, Consultant, GM Izhar Energy Service, Office # 03, 1st Floor Ross Residencial 1 Campus Road Canal Bank, New Wafaqi Colony, Lahore.	
27.	Abid Wahab Assistant Director (Curr), HEC H-9, Islamabad	Member
28.	Dr. Anjum Munir, Coordinator, Energy Systems Engineering, Faculty of Agricultural Engineering & Technology, University of Agriculture, Faisalabad.	Secretary

1. The meeting started with the recitation of Holy Verses from the Holy Quran by Prof. Dr. Zahid Mahmood, Convener, NCRC. Prof. Dr. Muhammad Naeem Khalid, Advisor (Academics) Higher Education Commission, Islamabad, welcomed the participants on behalf of the Chairman and Executive Director, HEC and briefed the aims and objectives of the meeting with particular focus on finalizing the curriculum of new discipline of Energy Systems Engineering at undergraduate level developed during the 1st meeting of NCRC held at HEC quarter Lahore during January 08-10, 2014 which was introduced by the University of Agriculture, Faisalabad (UAF). He greatly appreciated the efforts of UAF being the pioneer University in developing a new need based Engineering program. Prof. Dr. Naeem Khalid asked all the participants to discuss critically and finalize the new degree program developed during the 1st meeting of NCRC. The Advisor (Academics). Then requested the Convener to conduct further proceeding, of all technical sessions of the meeting for three days.

2. Prof. Dr. Zahid Mahmood, Convener, briefed about the curriculum draft developed during the 1st meeting of NCRC held at HEC quarter Lahore during January 08-10, 2014.

3. Prof. Dr. Muhammad Iqbal, Co-Convener, briefed the justification of launching the new discipline of Energy Systems Engineering with a focus on the energy crisis issues of the country with their solution through energy generation by exploiting Renewable Energy Sources.
4. Prof. Dr. Zahid Mahmood, Convener, asked Dr. Anjum Munir, Secretary, to give presentation on the scheme of studies and the course contents of Energy Systems Engineering undergraduate program developed during the 1st meeting of NCRC.
5. It was unanimously decided by the members of NCRC to develop also the major courses for post graduate program in Energy Systems Engineering.
6. The Committee, while proceeding of the meeting, considered the inputs given by the Members and achieved the following objectives for the new programs in Energy Systems Engineering both at undergraduate and postgraduate level:

    i. Development of scheme of studies of 4-years BS/BSc/BE Energy Systems Engineering Program and credit hours allocation against each course.
    ii. Development of Course Curriculum for MS/MSc/ME Energy Systems Engineering Programme and credit hours allocation against each course.
    iii. Incorporated the latest reading & writing material against each course.
    iv. Brought informality and developed minimum baseline courses in each and every course of study.
    v. Made recommendations for promotion/development of both the discipline.

5. After three days long deliberation, the Committee unanimously approved and finalized following two draft curriculums with nomenclatures of:

    i. BS/BSc/BE Energy Systems Engineering
    ii. MS/MSc/ME Energy Systems Engineering

The final draft of both the curriculums will be provided to all the Members of NCRC for final review and to submit their critical evaluation, if any, within one month. The Convener of the Committee thanked all Members from academic and research institutions of the country for sparing their valuable time and quality contribution towards presentation

of the draft curriculum/scheme of studies. The Committee highly admired the efforts made by the officials of HEC for making, excellent arrangements to facilitate the smooth work by the Committee and their comfortable stay at Lahore.

6. The meeting ended with the vote of thanks by the Chair to all the participants of the meeting.

Mission Statement

To produce trained human resource in the discipline of Energy Systems Engineering for exploiting energy resources to enhance economic growth of the country.

Justification

Potential exists for almost all types of renewable energies in Pakistan. These types include solar (PV and thermal), wind, biogas, micro-hydel/canal fall, biodiesel production, biomass/waste to energy production, geothermal, tidal/ocean energies, etc. On an average, solar global insolation 5–7 kWh/m^2/day exists in the country over more than 95% of its area. Wind speed 5-7 m/s persists in coastal region of Sindh and Balochistan province and in a number of North West frontier valleys. According to a survey, Pakistan possesses more than 20,000MW of economically viable wind power potential.

The rise in global energy demand has raised questions regarding energy security and increased the focus on diversification, generation and efficient allocation. The answer lies in the attainment of optimal energy mix through fuel substitution by promoting energy efficiency and renewable energy and interregional co-operation. However, oil and natural gas will continue to be the world's top two energy sources through 2040.

Pakistan's economy has been growing at an average growth rate of almost 3 percent for the last four years and demand of energy both at production and consumer end is increasing rapidly. Knowing that there is a strong relationship between economic growth and energy demand, the government is making all possible efforts to address the challenges of rising energy demand The Government of Pakistan is taking up the challenge of energy crises and trying to build a comprehensive plan of work in order to address the grave situation being faced by the country. Both the public and private energy sectors can address biomass/biogas, solar, micro-hydel and to some extent solid waste. Energy production by all the above means is established internationally and nationally. There is

a need to strengthen all the stake holders engaged in trying to explore possibilities of utilizing renewable energy in place of traditional scarce and expensive fossil fuel energy supplies.

Pakistan is blessed with 900 km long coastal belt having a huge potential of tidal and wind energy that needs to be exploited for power generation to meet the energy needs of the coastal area.
Huge untapped coal resources approximately 185 billion tones lying unintended in Thar Sindh can be explored and utilized to generate power in-order to meet the national energy needs.

The solar photovoltaic (PV) systems in Pakistan is another resource still requiring special attention to be focused for utilizing in pumping water at farms. The solar thermal applications can be used for steam generation, power generation, food processing, and essential oils extraction from medicinal plants. A huge amount of bio-waste from agriculture industry and household is another source of energy which can enable to produce more than 3000 MW in Pakistan. The energy produced from the biomass can be easily consumed in farm engines to pump water and other farm power operations. Additionally, the sugar mills producing biomass from sugarcane as a byproduct can be utilized to produce electricity.

Programme Objectives

- To impart sound engineering knowledge for developing efficient energy systems.
- To develop skills for solving energy needs by integrating science and engineering principles adaptable to changing organizational and social needs;
- To engage in individual projects and multi-disciplinary teams designing, evaluating, and recommending methods and strategies for the efficient production, processing and utilization of renewable or non-renewable energy and addressing the associated environmental challenges;
- Effectively communicating with management, coworkers, customers, clients and others in diverse environments;
- Engaged in life-long learning process to maintain professional competency through training, participation in professional activities and leadership.
- Employed in the public or private sectors in the areas of energy science, energy engineering or energy business management, or pursuing an advanced degree.

Department of Energy Systems Engineering

Overview

Energy Systems Engineering is an exciting and unique undergraduate program which we are going offer to meet energy crises by opening a new Department of Energy Systems Engineering. This BS/BSc/BE degree is a first of its kind in the country with the curriculum addressing the call for the development of alternative sources of energy and conventional fossil fuels at the undergraduate level.

More specifically, the program will incorporate elements of the old Fuel Science undergraduate program with the addition of courses focused on renewable energy and agro-energy engineering as well as professional electives on business, finance, and management. Graduates of the program will be able to understand engineering fundamentals and apply that knowledge to solving problems in the production, processing, storage, distribution, and utilization of energy using multiple techniques such as synthesis, analysis, design, and case studies and to incorporate with the agricultural processes.

This flexibility in the curriculum will make it an attractive dual or concurrent major and minor option for students in other energy-related programs as it prepares students to become valuable contributors in addressing society's energy needs and demands particularly in the field of agriculture.

In addition, the program will prepare students to be successful leaders in advancing the technology and management of energy; innovators and entrepreneurs in the energy sector; and academia, practicing engineers, and national leaders in the energy and associated environmental health and safety, policy and economic fields.

It will train students to be lifelong learners, problem solvers, and energy industry leaders. The curriculum will be sufficiently flexible, broad, and diverse to enable students to tailor their educational experience to particular interests, background, and expected role in the field of agriculture and society. The flexibility allows students in energy related programs such as agricultural and biological, chemical, electrical, environmental, mechanical, nuclear, and petroleum engineering, materials science and engineering, industrial health and safety, and business and finance to have dual or concurrent degrees, minors, or options.

Career Opportunities

With the world's thirst for energy continuing to grow, there is now an urgent demand for a well trained workforce to develop process, utilize and manage conventional, unconventional, and renewable energy sources in an environmentally safe and economically feasible way. Therefore, graduates of the Energy Systems Engineering program will have many diverse options that include the opportunity to:

- Become valuable contributors in addressing society's energy needs and demands, successful leaders in advancing the technology and management of energy, innovators and entrepreneurs in the energy sector.
- Join the workforce or continue on for advanced degrees in various areas of energy science, engineering, and business/management.
- Enter private or public sectors as Energy Engineers to evaluate and recommend energy generation, production and processing methods and strategies.
- Address critical energy management issues of various process industries especially extraction, production and conversion industries; design engineering systems to address energy production, processing and utilization.
- Contribute in designing/ developing novel catalytic/biological/chemical processes and/or maintaining upstream technologies for petroleum and natural gas processing industries or unconventional fuels such as coal to liquids or oil shale/ tar sands processing industries.
- Join automobile manufacturing industries to work in traditional internal combustion engines or develop novel fuel cell based vehicles.
- Join major power companies in designing /maintain-ing/developing environmentally sound renewable power systems such as wind, solar, hydro, and geothermal or coal, oil, or gas based power generation systems.

Internship Opportunities

Students enrolled in “Energy Systems Engineering” will have the opportunity to participate in the DOE Technical Careers Internship Program. The Departments of Energy may initiate the internship program to recruit qualified students.

Degree Requirements

The first two years of the program are focused on foundationl engineering courses. Thereafter, one takes a series of courses that

strengthen the “Energy Systems Engineering” concept. Foundation energy engineering principles involve material and energy balances, thermodynamics, fluid mechanics, heat and mass transfer operations, and physical and chemical processing as applied to energy industries. In addition to these engineering principles, students enroll in required courses in renewable energy principles. Students will be trained in basic chemistry of fuels - coal, petroleum, natural gas and biomass; combustion; petroleum and natural gas processing; electrochemical energy conversion; and energy conversion processes including chemical, nuclear, biological and catalytic. Students also choose departmental electives from courses such as green energy engineering and environmental compliance, hydrogen and fuel cell technology, materials for energy applications, physical processes in energy engineering, and air pollutants from combustion sources. Professional electives allow students to gain exposure to business, legal and ethical issues related to energy. Technical electives can be chosen to provide specialization or breadth and depth in renewable or non-renewable energy and/or mechanical or chemical aspects of energy. Students will also have opportunities to conduct independent research and participate in capstone design team projects with students from other engineering disciplines.

Expected Outcomes

If the curriculum prescribed for the undergraduate students is implemented effectively, the Energy Systems Engineering graduates would:

a. Possess essential engineering knowledge for meeting the requirements of industries and other organizations needing graduate engineers.
b. Have the academic background and basic research skills to pursue graduate studies at national and international level.
c. Possess the basic design/development skills and management/economic know how to enter the market as an entrepreneur.
d. Applying engineering knowledge, mathematical models and probabilistic/statistical tools to solve problems relating to energy.
e. Exploit renewable energy resources using hardware and software to solve the energy crises and to provide new solutions using innovative designs and techniques.
f. Function effectively in multi-disciplinary team for energy solutions.
g. Engage himself/herself in a lifelong learning process.
h. Acquire knowledge of contemporary issues and their correlation with the technologies.

i. Avoid real and perceived conflicts of interest whenever possible and disclose them to affected parties when they do exist.
j. Be honest and realistic in stating claims or estimates based on available data and reject bribery in its all forms
k. Seek, accept and offer honest criticism of technical work, acknowledge and correct errors and credit properly the contributions of others.
l. Treat fairly all persons regardless of such factors as raised religion, gender, disability, age, or regional origin.
m. Avoid damaging assets, reputation or employment by false or malicious actions.
n. Assist colleagues and co-workers in their professional development and support them in following the ethics.

BS/BSc/BE Energy Systems Engineering

Duration:	4 years
Number of semesters:	8
Number of weeks per semester:	6 18 (minimum 16 weeks for teaching and 2 weeks for examinations)
Total number of credit hours:	136
Number of credit hours per semester:	14 – 20

Scheme of Studies of BS/BSc/BE Energy Systems Engineering

First Semester

*Course No.	Title of the Course	Credit Hours
Engineering Courses		
ESE-	Metallurgy & Workshop Practices	4(2-2)
ESE-	Fluid Mechanics	4(3-1)
Non-Engineering Courses		
	Islamic Studies or Ethics (for Non-Muslim students)	2(2-0)
	Linear Algebra & Calculus	3(3-0)
	Applied Physics	3(2-1)
	Organic Chemistry	3(2-1)
	Total Credit hours	19(14-5)

Second Semester

Engineering Courses		
ESE-	Principles of Energy Engineering	2(2-0)
ESE-	Manufacturing Engineering	3(2-1)
ESE-	Engineering Mechanics	4(3-1)
ESE-	Engineering Drawing, Graphics, and CAD	3(2-1)
Non-Engineering Courses		
	Computer Programming and Applications in Engineering	3(2-1)
	Differential Equations, Power Series,	3(3-0)

	Laplace Transformation	
	Total Credit hours	18(14-4)

Third Semester

Engineering Courses		
ESE-	Electrical Engineering-I	4(3-1)
ESE-	Engineering Thermodynamics	3(2-1)
ESE-	Engineering Numerical Analysis	3(2-1)
Non-Engineering Courses		
	Pakistan Studies	2(2-0)
	English Composition and Comprehension	3(3-0)
	Sociology for Engineers	2(2-0)
	Total Credit hours	17(14-3)

Fourth semester

Engineering Courses		
ESE-	Instrumentation & Controls	4(3-1)
ESE-	Mechanics of Materials	3(2-1)
ESE-	Heat and Mass Transfer	3(2-1)
Non-Engineering Courses		
	Communication & Presentation Skills	3(2-1)
	Statistics and Probability	3(3-0)
	Operations Management	2(2-0)
	Total Credit hours	18(14-4)

Fifth Semester

Engineering Courses		
ESE-	Solar Energy Systems	3(2-1)
ESE-	Wind and Hydropower Conversion	4(3-1)
ESE-	Electrochemical Engineering Fundamentals	2(2-0)
ESE-	Boiler Engineering and Power Plants	3(2-1)
ESE-	Electrical Engineering-II	3(3-0)
Non-Engineering Courses		
	Non-Engineering Elective Course	2(2-0)
	Total Credit Hours	17(14-3)

Sixth Semester

Engineering Courses		
ESE-	Hydrogen and Fuel Cells	3(2-1)
ESE-	Bio-Energy Engineering	4(3-1)
ESE-	RS & GIS for Renewable Energy Resources	3(2-1)
ESE-	Heating, Ventilation and Air Conditioning Systems	4(3-1)
Non-Engineering Course		
	Microbial Bioenergy and Biofuels	3(2-1)
	Total Credit Hours	17(12-5)

Seventh Semester

Engineering Courses		
ESE-	Energy Conservation	3(3-0)
ESE-	I.C. Engines	3(2-1)
ESE-	Project and Report-I	3(0-3)
ESE-	Engineering Elective-I	3(2-1)
ESE-	Engineering Elective-II	3(3-0)
	Total Credit Hours	15(10-5)

Eighth Semester

Engineering Courses		
ESE-	Power Electronics	3(2-1)
ESE-	Energy Economics, Policy and Management	3(3-0)
ESE-	Project & Report-II	3(0-3)
ESE-	Engineering Elective-III	3(2-1)
ESE-	Engineering Elective-IV	3(3-0)
	Total Credit Hours	15(10-5)

Total Credit Hours for BSc Energy Systems Engineering = 136

Note:

1. A supervised internship training to be arranged by the Institution after sixth semester as the requirement of the degree (Grades: Excellent, Good, Satisfactory)
2. Project and Report will be completed in two semesters i.e. 7th and 8th.

Non-Engineering Elective

1. Photoactive Materials and their Characterization 2(2-0)

2. Professional Ethics 2(2-0)
3. Energy and Environment 2(2-0)

Engineering Elective-I

- Renewable Energy Engineering 3(2-1)
- Petroleum and Gas Exploration 3(2-1)
- Geothermal and Tidal Energy 3(2-1)

Engineering Elective-II

- Fuels & combustion 3(2-1)
- Environmental Impact Assessment 3(3-0)
- Theory of Machines 3(2-1)

Engineering Elective-III

- Nuclear Energy Engineering 3(3-0)
- Nano Technology and Energy 3(3-0)

Engineering Elective-IV

- Clean Coal Technology 3(2-1)
- Machine Design 3(3-0)

ESE-	Metallurgy & Workshop Practices	4(2-2)

Objective

To enable the students to analyze the properties and characteristics of metals and their treatments. The students will be provided the opportunities to learn and exercise various workshop practices to enhance their engineering skills.

Contents

Safety and First Aid, Production and properties of common engineering materials: Ferrous metals, iron ores, properties and uses of pig iron, cast iron, wrought iron, steel, standard processes of manufacturing of Iron and steel, open hearth process, basicoxygen processes, production of ingots. Composition/properties and uses of plastics, rubber, fibre glass and composite materials.

Alloy steel and Irons: Effect of alloying elements, the AISI/SAE alloy steel and their identification, corrosion resistant steel, steel for high temperature services, alloy steel. Non-ferrous metals: Properties and uses of copper, aluminum, zinc, tin, nickel, and lead. Non-ferrous alloys, copper alloys. Aluminum alloys, zinc base alloys, nickel base alloys. Lead-tin alloys, iron-carbon equilibrium diagram.

Heat treatment theory and process, heat treatment of steel, annealing, hardening, tempering, normalizing, surface hardening, quenching, heat treatment equipment.

Types of welding process, welding materials, inspection and testing of welded joints, Welding flames and materials, cutting of metals, gas welding processes. Foundry, casting, hand molding tools, foundry cores, properties of core and, crucibles, handling and care.

Practical

Identification of tools and machines in the workshop; Identification of different metals by spark tests and advance methods; Demonstration of different heat treatment processes; Practice of arc welding; Practice of gas welding; Safety and first aid in the workshop related to electrical, mechanical and other accidents. Safety in the use of hand tools; Visits to local foundries.

Suggested Readings

1. Chapman, W.A.J. 2004. Workshop Technology Part-I. and II. Viva Books Private Ltd., India.
2. Johan, K.C. 2010. Mechanical Workshop Practices, 2nd Ed. Prentice-Hall of India Private Ltd., India.
3. Ostwald, P.H. and J. Munoz. 2002. Manufacturing Processes and Systems, 9th Ed. John wiley and Sons, New York. USA.
3. Rao.P.N. 2002. Manufacturing Technology: Metal cutting and machine tools.Tata McGraw, Hill Co. Ltd., New Delhi, India

ESE-	Fluid Mechanics	4(3-1)

Objective

To study the fundamentals of fluid mechanics including statics and kinematic, concept of energy, momentum, forces and flow measurement.

Contents

Definition and branches of fluid mechanics, distinction between solid and fluids, Properties of fluids: density, viscosity, surface tension, specific weight, specific gravity, etc., bulk modulus of elasticity, compressibility of fluids.

Pressure variations in a fluid, pressure measuring devices, gauges and manometers, buoyancy and stability of submerged and floating bodies, forces on plane and curved surfaces, center of pressure.

Types of flow, dimensions of flow, streamlines, path lines, flow patterns for different references, continuity equation, source flow, sink flow, flow nets, uses and limitations of flow net. General equations of steady flow, heads, Bernoulli's equation and its practical applications, hydraulic and energy grade lines, power consideration in fluid flow, cavitation's, head losses, solution of flow problems.

Impulse-momentum principle and application, force exerted on a stationary and moving bodies (flat and curved), relation between absolute and relative velocities, reaction of a jet, jet propulsion, torque in rotating machines.
Orifices, weirs, notches and venture meter, pitot tube, coefficient of contraction, velocity and discharge, derivation of their discharge formulae and their applications.

Practical
Demonstration of various parts of hydraulic bench; Experimental study of laminar and turbulent flow; Experimental study of tube gauges and dead weight pressure gauges; Calibration of orifices by various methods; Calibration of Venturimeter; Calibration of rectangular and triangular notch; Verification of Bernoulli's theorem; Determination of metacentric height; Viscosity of a given fluid by viscometer; Drag on a small sphere.

Suggested Readings

1. Cengal, Y. and J.M. Cimbala. 2013. Fluid Mechanics Fundamental sand Applications, 3rd Ed. McGraw-Hill Higher Education, London.
2. Jain, A.K. 1990. Fluid Mechanics: A Text Book for Engineering Students. Khana Publishers, New Delhi, India.
3. Streeter, V.L. 1988. Fluid Mechanics, 8th Ed. McGraw Hill Inc, New York. USA.
4. Daughterty, R.I., J.B., Franzini, and E.J. Finnemore. 1995. Fluid Mechanics with Engineering Application, McGraw Hill Book Co. Singapore.
5. White, F. 2010. Fluid Mechanics, 7th Ed. McGraw-Hill Sceince /Engineering/Math, Plainfield II. USA.

ESE-	Principles of Energy Engineering	2(2-0)

Objective
An introductory course introducing concepts of energy and renewable energy sources.

Contents

History of energy usage, forms of energy, present energy consumption, environmental problems, Current status of conventional and renewable energy sources: World and Pakistan scenario, energy and power; fossil fuel and nuclear, Solar thermal energy:- Solar radiation resource, passive and active solar heating, solar concentrators Solar photovoltaic:- Basic PV operation, PV technologies, electrical characteristics Biomass:- Definitions, biomass resource, extracting biomass energy, fuel crops, anaerobic digestion, landfill gas, waste to energy, energy balances and economics. Hydroelectricity:- the resource, hydropower power equation, turbines, large and small scale systems, pumped storage.

Tidal Power:- The tides, tidal resource, system operation, environmental factors Wind energy:- generation of the winds, wind resource, basic aerodynamics (lift versus drag) and the fundamental power equation; fundamental design concepts Wave energy:- The wave resource, the fundamental power equation; onshore and off-shore wave energy extraction systems.

Geothermal Energy:- Introduction, nature of fields, Classification of Geothermal Resources, Introduction to geothermal steam electric plants, Liquid Dominated System: Flashed Steam System, Total Flow Concept, Geothermal exploration Fuel Cell:- Introduction and Classification, Reactions and Configurations.

Suggested Readings

1. Duffie, J.A. and W.A. Beckman. (latest). Solar Engineering of Thermal Processes, 2nd Edition, John Wiley & Sons,.
2. Boyle, G. Renewable Energy: Power for a Sustainable Future. 2nd Edition, OUP and Open University, 2004, ISBN 019926178-4.
3. Boyle, G., B. Everett, and J. Ramage. 2003. Energy Systems and Sustainability, OUP and Open University, 2004, ISBN-13: 978-0199261796.
4. Scheer, H., A Solar Manifesto, James & James, 2004, ISBN 1 902916 24 7.
5. Kalogirou, S.A. 2009. Solar Energy Engineering: Processes and Systems. 1st Ed. British Library. ISBN 978-0-12-374501-9. Printed in USA.
6. B. Viswanathan, M. Aulice Scibioh. 2007. Fuel Cells: Principles and Applications. Taylor & Francis Group, 2007.

ESE	Manufacturing Engineering	3(2-1)

Objective

The course introduces the concepts and practicalities of manufacturing technology, its benefits, limitations & appropriate use. The engineers/students will develop sound understanding about how to manufacture goods, using various methods and techniques.

Contents

Turning and related operations: Lathe, construction, types of lathes, accessories, lathe operations, turret lathe; construction, types, turret lathe tooling, chip formation, mechanism of chip formation, cutting tools and their types, tool materials, tool failure and tool life.

Shaping and planning: shaper; classifications, functions, shaper drive, mechanism, shaper speeds and machining times, planning, construction and types, work set up, planer tools, metal bending and sheet rolling processes.

Drilling and reaming: Drilling; types and sizes, drill chucks. Counter boring, counter sinking, reaming, drilling machine types, and estimating drilling time.

Milling: Definition, milling operations, milling cutters, milling machines types, size, accessories, dividing head, estimating milling time.
Computer-aided manufacturing (CAM) and computer–integrated manufacturing (CIM) Systems: Machine tools control, numerical control system, computerized numerical control system (CNC) programming for numerical control.

Welding and classification of welding processes, oxyacetylene gas welding (OAW), shielded metal arc welding (SMAW), designation system for arc welding electrode, resistance spot welding (RSW), resistance seam welding (RSW), forge welding (FOW), weldability and weld quality, weld design and process selection

Practical

Fabrication of various machine elements using lathe; Making a slot on a shaft for a cotter pin using shaper and milling machines; Cutting threads using milling and lathe machines; Making holes in machine parts using drilling machines; Making bends of metal sheet using sheet rolling machines; Fabrication of a given agricultural machinery part; Local visits to agricultural Machinery Manufacturing Industries.

Suggested Readings

1. Kalpakjian, S. and S. Schmid. 2007. Manufacturing Processes for Engineering Materials, 5th Ed. Pearson Education, New

Delhi. India.

2. Kalpakjin, S. and R.S. Schmid. 2004. Manufacturing engineering and technology, 4th Ed. Tata McGraw Hill Co. Ltd, New Delhi. India.
3. Ostwald, P.H. and J. Munoz. 2002. Manufacturing Processes and Systems, 9th Ed. John Wiley and Sons, New York. USA.
4. Rao, P.N. 2005. CAD/CAM -Principles and applications, 2nd Ed. Tata McGraw Hill Co. Ltd, New Delhi. India.

ESE-	Engineering Mechanics	3(2-1)

Objective
Teaching basic principles of force analyses in engineering systems.

Contents
Concept of measurement of mass, force, time and space, Systems of units, Fundamentals & Derived units, Conversion of units, required Accuracy of results, General Principles of Statics, Vector addition, Subtraction and Products, Resultant of Distributed (Linear & Non-linear) force Systems, General conditions of equilibrium of Co-planer forces, Laws of Triangle, Parallelogram and Polygon of forces, Types of beams, Supports and Loads, Simple cases of Axial forces, Shear forces and Bending Moment diagrams, Problem involving friction on Flat surfaces, Geometrical Properties of Plane Areas, Work, Energy, Power, Impulse, Momentum, Conservation of Momentum and Energy, Rectilinear and Curvilinear motions, Tangential and Normal Components of Acceleration, Simple Harmonic motion.

Practical
To verify the law of polygon of forces, the law of parallelogram of forces, the principles of moments, the co-efficient of friction between surfaces. Special numerical problems and assignments; Moment of inertia of fly wheel mounted on wall and a wooden block by suspension.; Efficiency of various models of machines; Modulus of rigidity of metal bar by static and dynamic methods; Special numerical problems and assignments.

Suggested Readings
1. Singer, F.L. 2000. Engineering Mechanics 3rd Ed. Harper and Row Publishers, New York. USA.
2. Meriam, J.L. and L.G. Kraige. 1993. Engineering Mechanics. Vol.I 3rd Ed.I Statics. John Willy and Sons, New York. USA.

3. Higdon, A. and W.B. Stile. 1986. Statics. And Dynamics. 3rd Ed. Prentice-Hall, , USA.
4. Riley, W. and L.D. Struges. 1995. Engineering Mechanics, Static's and Dynamites, 2nd E. John Wiley & Sons, New York. USA.
5. Bedford, A. and W. Fowler. 1994. Engineering Mechanics: Statics: Statics and Dynamics, Vol. 1 & 2. Addison-Wesley Publishing Company, New York. USA.
6. McGill, D.J. and W.W. King. 1994. Engineering Mechanics: Statics and Dynamics, 3rd Ed. PWS publishing Co, New York. USA.

ESE- Engineering Drawing, Graphics, and CAD 3(2-1)

Introduction to engineering drawing, various types of lines, basic geometrical constructions, conic sections, theory of orthographic projection, dimensioning & lettering, Introduction to tolerance, projections off points, projections of straight lines, Projections of planes and solids in simple position, sectioning of solids, Isometric projections, development of surfaces.

Drawing Sketches. Working with drawing Aids. Basic Dimensioning and Tolerancing. Model Space view ports, Paper space view ports and Layouts. Plotting Drawing. Hatching Drawing. Working with Blocks. Working with Advanced Drawing Options. Technical Drawing with AutoCAD. Isometric Drawing. The User Coordinate System. Getting Started with 3D. Creating Solid Models. AutoCAD on the Internet

Practical

Introduction to drawing instruments and their use, various scales, practice of orthographic projection missing lines in orthographic projection, Drawing three views of different objects, Practice of Dimensioning and Lettering, Practice of Sectioning, Conversion of orthographic projection into isometric view, Creating drawings of Engineering Fasteners like Rivets, Cotters Joints, threads etc. Drawing and working problems on AutoCAD Mechanical Power Pack Package

Suggested Readings

1. Autocad. 2004. Autocad Mechanical Power Pack, Autodesk New York, USA.
2. AutoCAD. 2005. A problem–Solving Approach Autodesk Press Sham Tickoo.
3. David A. and D.P. Madsen. 2011. Engineering Drawing and Design 5th Ed. DELMAR CENGAGE Learning Mason USA OH.

4. French, T.E. and C.J. Vierch. 1953. A Manual of Engineering Drawing, 8th Ed. McGraw Hill Book Company, New York. USA.
5. James, H.E. 1992. Engineering Design Graphics, 7th Ed. Addison-Wisley Publishing Company, New York. USA.
6. James, H. Earle. 1992. Engineering Design Graphics, Addison-Wisley Publishing Co. Reoding Massachusetts.
7. Lang, K.L. and A.J. Kalameja. 2011. AutoCAD 2012 Tutor for Engineering Graphics, 1st Ed. DELMAR CENGAGE Learning, Minneapolis USA.
8. Parkinson A.C. 1998. A First year Engineering Drawing, 6th Ed. Sir Isaac Pitman and Sons Ltd., England.

ESE-	Electrical Engineering-I	4(3-1)

Practical

Study the different electrical circuit designs with circuit symbols; Practical demonstration of Ohms law and Kirchhoff's law; Demonstration of DC and AC current circuits and their measurements; To determine the characteristics of conductors and semiconductors.

PSPICE Software, MATLAB/SIMULINK Software, Power System Analysis Using ETAP Software, KW, KVAR, KVA, KWH, Energy Demand, Power Factor, Phase Angle, Over Voltage, Over load, Load Factor, Diversity Factor, Stability, Steady State, Transient State, Insulation Coordination, Leakage Current, Voltage Regulation, Voltage Control, VAR Control, Harmonic/Distortion; Analysis of Waveforms in Modern Power Systems; Frequency Analysis Of Non-Sinusoidal Waveforms: Practical Considerations, Analog-to-Digital Conversion, Sequence Component Analysis, IEEE 1459: Power Definitions for Modern Power Systems, Localization of Sources of Waveform Distortion in a Modern Power System. Electric Substations; Substation Equipment, Transformers, Regulators, Circuit Breakers; Reclosers, Disconnect Switches, Lightning Arresters, Electrical Bus, Capacitor Banks, Reactors, Static VAR Compensators, Preventative Maintenance.

Basics of Power System Control, Active Power and Frequency Control, Voltage Control and Reactive Power, Control of Transported Power, Flexible AC Transmission Systems (FACTS). Grounding requirements, methods and systems.

Suggested Readings

1. Hughes, E. and I.M. Smith. 1995. Hughes Electrical Technology, 7th Ed. Longman Sc & Tech, UK.,
2. Gupta, B.R. 2001. Principles of Electrical Engineering, revised Ed. S. Chand and Company Ltd, New Delhi. India.

3. Smith, I.M. 1972. Basic Electrical Engg. Science, Illustrated Ed. Longman, Northbrook. IL. USA.
4. Storey, N. 2004. Electrical & Electronics Systems, Illustrated Ed. Pearson Education Limited, Canada..
5. Warnes, L. 2003. Electronic and Electrical Engineering Principles and Practice, 3rd Ed. Palgrave Macmillan, New York. USA..
6. Storey, N. 2006. Electronics: A Systems Approach, 3rd Ed. Prentice Hall, USA.
7. Floyd, T.L. 2007. Electronics Fundamentals: Circuits, Devices and Applications, 7th illustrated Ed. Prentice Hall, USA.
8. Hambley, A.R. 2007. Electrical Engineering: Principles and Applications, 4th Ed. Prentice Hall, USA.
9. Mohan, N., T.M. Undeland. and W.P Robbins. 2003. Power Electronics: Converters, Applications and Design, 3rd Ed. John Wiley & Sons, New York. USA.

ESE-	Engineering Thermodynamics	3(2-1)

Objective

To educate the students about various thermodynamic cycles of heat engines and refrigeration systems.

Contents

Heating and expansion of gases: Units of heat, gases and vapors, constant volume and constant pressure, P-V diagram, specific heat of gases, internal energy of gas, law of conservation of energy, methods of heating and expanding gases and vapors, work done by gas in expanding.

Laws of perfect gases: The two laws of thermodynamics, the heating of gases, equations for different types of heating methods. Air cycles: Cycles of operation, air standard efficiency of a cycle, reversible process, reversible cycles, reversibility and efficiency, Carnot cycle, Otto cycle, diesel cycle, mean effective pressure.
Entropy of gases: Entropy and heat, T-S diagrams, Carnot, Otto, diesel and dual combustion cycles on T-S diagrams.

Air compressors: functions, compressor types, reciprocating and rotary compressors, single and multistage compressors, cylinder clearance, work done, compressor efficiency.
Compound expansion: advantages of compound expansion, tandem type of two- cylinder compound engine, receiver type compound

engine; combined indicator diagram for compound engine, Calculations for cylinder uni-flow engine.

Fuels: Combustion of fuels, properties of fuels – viscosity, pour point, flash point, calorific value, API gravity, conversion of volumetric analysis, analysis by weight, weight of carbon in burnt gases, weight of air required for complete combustion of fuel, weight of flue gases per pound of fuel burnt, weight of excess air supplied, method of analyzing flue gases, heat carried away by flue gases, volumetric analysis of a gas, air fuel ratio for I.C. Engine.

Refrigeration: Co efficient of performance, units of refrigeration, air compression refrigeration, vapor compression refrigeration, refrigeration cycles, rating, quality of refrigerant and general considerations, components of refrigeration system, heat pumps.

Practical

Study of working principles of two stroke and four stroke engines using models; Demonstration of Joule's law; Study of rotary and reciprocating air compressors and their characteristic curves; Study of PV diagram of diesel/gasoline engines; Analysis of engine flue gases for CO, CO_2, NO_2, etc.; Determination of energy content of different fuels using calorimeter; Study of heat transfer using refrigeration and air conditioning cycle; Measurement of fuel viscosity using viscometer; Determination of flash point and fire point of different petroleum products.

Suggested Readings

1. Khurmi, R.S. and J.K. Gupta. 2000. Thermal Engineering, 14th illustrated Ed. S. Chand & Co. Ltd, New Delhi. India..
2. Sontagg, R. E. and G. J. Van Wylen. 2010. Fundamentals of thermodynamics. 7th ed., John Willey and Sons, Inc. New York, USA.
3. Jones, J.B. and G.A. Hawkais. 2002. Engineering Thermodynamics. 2nd Ed. John Willey and Sons, New York. USA.
4. Lewitt, E.H. 1953. Thermodynamics Applied to Heat Engines, 5th Ed. Isaac Pitman and Sons, London.
5. Eastop, T. D. 2004. Applied Thermodynamics for Engineering and Technologists, 5th Ed. Pearson Education, Singapore.

ESE-	Engineering Numerical Analysis	3(2-1)

Objective

To train the students in solving engineering problem and numerical computational techniques

Contents
Finite difference, Forward, backward and central difference and its operators form, Interpolation and extrapolation; Linear and higher order interpolating polynomials, Newton's Gregory forward and backward difference interpolation formulas and its utilization as extrapolation, Lagrange interpolation and extrapolation, Numerical differentiation based on differences, Numerical integration; Trapezoidal and Simpson' approximations, Trapezoidal and Simpson's extrapolations by Romberg integration process, Numerical Solution of non-linear equations; Bracketing and iteration methods and its applications as multiple root methods, Direct solution of the system of linear equations; Gauss-elimination, Direct and indirect factorization, symmetric factorization, tridiagonal factorization, Iterative methods like Jacob's iteration and Gauss-Seidel iteration, Numerical solution of initial value problems; Single-Step methods like Euler's method, Euler's modified method, Runge-Kutta method and its comparison with Taylor's series expansion, Multi-steps methods like Adams Bashforth and Modulation two and three step methods, Higher order differential equations, system of differential equations, Numerical solution of linear and nonlinear boundary value problems.

Practical
Numerical solution techniques will be elaborated and demonstrated.

Suggested Readings

1. Bhat, R.B. and S. Chakraverty. 2004. Numerical Analysis In Engineering illustrated Ed. Alpha Science International, USA.
2. Moin, P. 2010. Fundamentals of Engineering Numerical Analysis. 2nd Ed. Cambridge University Press. New York. USA.
3. Sastry, S.S. 2005. Introductory Methods of Numerical Analysis, 4th Ed. PHI Learning Pvt. Ltd, India.

ESE-	Instrumentation & Controls	4(3-1)

Objective
To train the students about the instrumentation techniques to monitor and control the operation of machines/equipment.

Contents
Terminology used in process measurements, range of sensors and transducers with reference to manufacturers' terminology, construction and operation of modem sensors used to measure pressure, level, temperature and flow, typical applications for the sensors, signal conditioning and transmission, process control terminology, open and close loop control systems, Determine the medium required for

successful transmission 'name sensors, conditioners and display units for a range of specific purposes, tuning techniques, control actions required for different systems, main parts of a regulating unit, regulating unit with reference to standard terminology, including manufacturers' specifications, Select the plug characteristics required for a specified process, characteristics of a range of regulating units, use of valve positioners, CV of a control valve from relevant data

Practical

Measurement of Displacement by LVDT and Potentiometer; Measurement of wind velocity; Measurement of Force by Strain Gauges; Calibration of pressure gauges with dead weight tester; Measurement of Temperature by thermocouples; Computer inter-facing for the depth and draft controls of tractors; Visit to Mechatronics labs of different institutions; Study of depth sensors.

Suggested Readings

1. Haslam, J.A, G.R. Summers, and D. Williams. 1982. Engineering instrumentation and control. 1st Ed. Kindle Edition.
2. Bolton, W. 2004. Instrumentation and control system, 1st Ed. Elsevier Ltd, oxford. UK.
3. Necsulescu, D.S. 2002. Mechatronics illustrated Ed. Prentice Hall Inc., N.J. USA.
4. Figliola, R.S. and D.E. Beasley. 2004. Theory and design for Mechanical measurements. 3rd Ed. John Willey & Sons, Singapore.
5. Dally, J.W., W.F. Riley and K.G. McConnel. 2003. Instrumentation for engineering measurements, 2nd Ed. John Willey and Sons, Singapore.
6. Shetty, D. and R.A. Kolk. 2010. Mechatronics system design, 2nd Ed. Vikas Publishing House, Pvt, Ltd, New Delhi. India.
7. Mahalik, N.P. 2003. Mechatronics, principles, concepts and applications. 2nd Ed. Tata McGraw Hill, New Delhi. India.

ESE	Mechanics of Materials	3(2-1)

Objective

Developing an understanding of design of building and machine elements from stress – strain standpoint.

Contents

Stress and strains: Stress at a point, components of stress, analysis of plane stress, principle stresses, maximum shear stress, Mohr's circle.

Axial loading: Stress due to axial forces, strain, properties of material under axial loading. Bending: Bending stresses in beams, shear and bending moment diagrams.
Combined loading: Stresses due to axial, bending and torsional loading.
Deflection: Moment-curvature relationship, deflection of beams by the method of double integration. Deflection of beams: Double integration method with singularity function, area moment method, Torsion: Shearing stress and angle of twist, hollow and circular shafts.
Buckling: Pin ended column, eccentrically loaded column, initially curved column, critical loads and critical stresses.

Curved beams: Stresses in curved bars. Cylinders and spheres: Stresses in thin and thick walled cylinders. Fatigue loading: analysis and design.

Practical
Practical exercises related to axial loading, bending torsion and deflection of beams; buckling, curved bars, strain gauges and fatigue loading; Special numerical problems and assignments.

Suggested Readings

1. Muvdi, B.B. and J.W. Mcnabb. 2001. Engineering Mechanics of Materials, 3rd Ed. Macmillan Publishing Co, New York. USA.
2. Shigley, J.E. and L.D. Mitchell. 1983. Mechanical Engineering Design, 4th Ed. McGraw Hill Book Co, New York. USA.

ESE-	Heat and Mass Transfer	3(2-1)

Heat Transfer-Thermodynamics and heat transfer, engineering techniques in heat transfer, different forms of energy, heat transfer mechanisms; Principles of convective, conductive and radioactive heat transfer, shell balances concerning heat transfer, heat transfer coefficient correlations, boiling and condensation, thermal design of heat exchangers, transient heat transfer. Equations of change for isothermal systems, macroscopic balances for isothermal systems, analytical, approximate solutions to equations of heat, transfer, momentum, energy transport, interphase momentum, heat transfer. Empirical model the evaluation of heat transfer coefficients.

Mass Transfer - Introduction, analogy between heat and mass transfer, mass diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, diffusion in moving medium, mass convection, simultaneous heat and mass transfer. Principles of diffusion, mass transfer in turbulent flow, mass transfer theories, general principles

of stage wise and continuous contacting operations, applications to absorption and distillation.

Practical
Method of heat transfer; Measurement of heat transfer by different methods; Study of boiling and convection heat transfer; types of heat exchangers, thermal processing; Experiments related to heat transfer from food products.

Suggested Readings

1. Baehr, H.D. and K. Stephan. 2011. Heat and Mass Transfer, 3rd Ed. Springer Berlin Heidelberg, Germany.
2. Çengel, Y.A. 2003. Heat Transfer-A Practical Approach, 2nd Ed. McGraw Hill, USA.
3. Thrimulashwar, M. 2009. Fundamentals of Heat and Mass Transfer, 2nd Ed. Pearson Education Published Dorling Kindersley, Pvt. Ltd. India.

ESE-	Solar Energy Systems	3(2-1)

Learning Objectives
1. Learn the fundamentals of solar energy conversion systems, available solar energy and the local and national needs, solar engineering applications, emerging technologies,
2. Understand the interdisciplinary approach for designing stand-alone PV systems, predicting performance with different systems, Implementing design with cost analysis.

3. Gain system engineering expertise related to photovoltaic energy conversion: generation, storage, and grid connection processes for residential and industrial applications, and Learn how to advance the current technology of the solar energy systems for making the process economical, environmentally safe and sustainable. Be able to serve industries or academia involved in sustainable energy engineering.

Contents
Solar energy: solar insulation vs. world energy demand, current energy consumption from different sources, environmental and health effects. Sustainable Energy: production and storage, resources and utilization. Fundamentals of solar cells: types of solar cells, semiconducting materials, band gap theory, absorption of photons, excitons and photoemission of electrons, band engineering; Solar cell properties and design; p-n junction photodiodes, depletion region, electrostatic field across the depletion layer, electron and holes transports, device physics, charge carrier generation, recombination and other losses, I-V

characteristics, output power; Single junction and triple-junction solar panels, metal-semiconductor hetero junctions, and semiconducting materials for solar cells. Low, medium and high temperature collectors, types of solar energy collectors; Heat storage, storage media, steam accumulator, other storage systems, heat exchangers and applications of stored energy. Thermoelectricity, Peltier effect, See beck effect; Thermoelectric materials, Bismuth telluride, automotive thermoelectric generators, radioisotope thermoelectric generator; Thermoelectric power generators, thermoelectric refrigerators and heat pumps.

Practical

Identification of different types of solar cells; Exercises to draw I-V characteristic curves, demonstration and evaluation of PV system; Performance evaluation of solar PV pumping system for irrigation applications, demonstration of PV cell manufacturing processes and visit to different solar research organizations, data acquisition using on-grid and off-grid PV system.

Recommended Books

1. Green, M.A. 1998. Solar Cells: Operating Principles, Technology and system Applications, Kensington, N.S.W. University of New South Wales.
2. Goswami, D.Y. 2000. Principles of Solar Engineering, 2nd Ed. Taylor and Francis, USA.
3. and Francis, 2000, ISBN 10: 1-56032-714-6
4. Wenham, S.R., M.A. Green., M.E. Watt. And R. Corkish. 2007. Applied Photovoltaics, 2nd Ed. Earthscan, USA.
5. Lasnier, F. and T.G. Ang. 1990. Photovoltaic Engineering Handbook, Adam Hilger. 1st Ed. IOP Publishing Ltd, Bristol. USA.
6. Sze, S.M. 2001. Semiconductor Devices, Physics, and Technology, 2nd Ed. John Wiley & Sons, New York. USA.

ESE-	Wind and Hydro Power Conversion	4(3-1)

Introduction, Properties and Statistical Analysis of the Wind, Wind Generators History, Wind Shear, Roughness Classes and Turbine Energy Production, Fluid Mechanics, Euler and Bernoulli Equations, Aerodynamics of Rotor Blades, Energy and Power Content of the Wind, Wind Energy Conversion Theory, Betz Equation, Torque Generation in Wind Turbines, Optimal Rotor Tip Speed Ratio, Components of Wind Machines Orography and Wind Turbine Siting, Offshore Wind Farms Siting, Airborne Wind Turbine Concepts.

Vertical Axis Wind Turbines, Small Wind Generators, Modern Wind Generators, Wind Turbines in the Urban Environment, Dynamic and

Structural Loading in Wind Turbines, Fatigue Loading in Wind Turbines, Wind Energy Converters Concepts, Control of Wind Turbines, Computational Fluid Dynamics, Random Numbers Generation, Economics of Wind Energy, Energy Storage with Wind Power Functioning of a hydropower system; classification of the typologies of hydropower systems and main components. Classification of hydropower plants. Reversible hydropower plant. Classification based on the size of the system.

Practical

Demonstration of different parts of Wind Turbine, performance evaluation and Energy measurement of a wind turbine, determination of wind tip speed for different sized wind turbines, calculation of transformation of a wind turbine, visit of wind power plant for mechanical and electrical energy, Application of Bernoulli's principle in the laboratory, Demonstration of impulse and reaction turbines model, power calculation from hydel turbine, Visit to Hydel power plant.

Recommended Books

1. Du, P. and N. Lu. 2014. Energy Storage for Smart Grids: Planning and Operation for Renewable and Variable Energy Resources (VERs). 1st Ed. Academic Press, USA.
2. Moore, T.R. and E.I. Bailey. 2012. Wind Power: Systems Engineering Applications and Design Models, Nova Science Publishers Inc, UK.
3. Wagner, H.J. and M. Jyotirmay. 2011. Introduction to Hydro Energy Systems, 1st Ed. Springer-Verlag Berlin Heidelberg.

ESE-	Electro Chemical Engineering Fundamentals	2(2-0)

Basic concepts

Electrochemical processes, Importance of surfaces, Anode, Cathode, Electrolyte, Three-phase boundaries, Anodic and cathodic currents, Polarization, Galvani and Volta potentials, Redox reactions and charge transfer reactions: Reduction and oxidation, Oxidation numbers, Charge transfer reactions, Half-reactions, .

Loss mechanisms and over potentials: Activation losses and fuel crossover, Electronic conductivity of electrolyte, Ohmic losses, Mass transport losses, Bubble formation, Activation over potential, Reaction overpotential, Resistance overpotential, Concentration overpotential, Transfer overpotential,

Electrode kinetics:
Transition states and energy barriers, Electrode and electrolyte double layers, Exchange current density, Butler-Volmer equation, Tafel plots, Rate determining steps Electrocatalysis

Recommended Books

1. Oldham, K.B., J.C. Myland. And A.M. Bond. 2012. Electrochemical Science and Technology, 4th Ed. John Wiley & Sons, USA.
2. Wang, J. 2006. Analytical Electrochemistry, 3rd Ed. John Wiley & Sons, USA.
3. Bagotsky, V.S. 2006. Fundamentals of Electrochemistry, 2nd Ed. Joh Wiley & Sons, USA.
4. Zoski, C.G. 2007. Handbook of Electrochemistry, 1st Ed. Elsevier, Neatherland.
5. Web based resources

ESE-	Boiler Engineering and Power Plants	3(2-1)

Objective

To produce skill about design, operations and maintenance of different types of boilers and steam turbines for power generation in industrial application

Contents

Boiler Engineering: Introduction, types, construction, mounting, accessories steam cycle, steam nozzles, supersaturated expansion in nozzles, heat drop in saturated and supersaturated expansion, steam injector, steam turbine, work done, velocity diagram, work done in blading, velocity compounding, pressure compounding, impulse turbine, heat account for boiler and turbine, amount of fuel burnt, acceptance tests, analysis and calorific value of fuel, analysis of flue gases, amount of steam produced, pressure and quality of steam, design of boiler and pressure control system devices. Properties of steam, enthalpy of water, dryness fraction, enthalpy of wet steam, use of steam tables, super heated steam, internal energy of steam.

Power Plants: Steam Plants: Introduction, general layout of modern steam plants, steam generators, engines and auxiliary components, back pressure and pass out turbines, deviation of actual cycle from ideal, turbine pump and condenser. Gas Turbine and Power Plants: Introduction, the gas turbine cycle, modification in basic cycle, isentropic efficiency of compressors and turbines, inter cooling and reheating, explosion type gas turbine with solar heating, development and improvement in gas turbine. Jet propulsion plant, comparison of steam and gas power plants.

Practical
Demonstration and inspection of different types of boilers; Determination of calorific value of fuel; Analysis of flue gases using gas analyzer; Quality analysis of steam; Measurement of impulse force on vane of turbine; Assessment of power generation at output shaft; Visit to different power plants; Visit to sugar and textile industries to study boilers and steam power; Visit to nuclear and steam power plants.

Suggested Readings

1. Chattopadhyay, P. 2000. Boiler Operation Engineering, 2nd Ed. TATA McGraw Hill Pub. Co. Ltd, New Delhi. India.
2. Kearton, W.J. 1999. Steam turbine theory and practice, 7th Ed. CBS publishers & Distributors, New Delhi. India.
3. Granet, I. and M. Bluestein. 2001. Thermodynamics and heat power, 6th Ed. Pearson Education Asia, New Delhi. India.
4. Cengel, Y.A. and R.H. Turner. 2005. Fundamentals of thermal fluid sciences, 2nd Ed. McGraw Hill International, USA.

ESE-	Hydrogen and Fuel Cells	3(2-1)

Contents
Fuel-cell technologies, possible fuels, and their applications solid oxide fuel cells (SOFCs).

Contents
Hydrogen as Future Energy Carrier. Introduction: Hydrogen Fuel Cell Engines and Technologies, Hydrogen Properties, thermal, electrolytic, Photolytic processes of hydrogen decomposition. Hydrocarbon Decomposition water decomposition. Hydrogen Distribution, Hydrogen Storage. Hydrogen Use in Internal Combustion Engines; Hydrogen feeding system, air feeding system, thermal management system, Integrated Fuel Cell System. Hydrogen feedstock and basics of its reforming; Fuel Cell Principles; Introduction to fuel-fuel cell types, basic principles; Fuel cell thermodynamics; Fuel cell reaction kinetics; Charge transfer in fuel cells; Mass transport in fuel cells; Fuel cell characterization. Overview of fuel cell types; Proton exchange membrane and solid oxide fuel cell materials
Overview of fuel cell systems.

Practical
Physical characterization of Fuel Cells, Hydrogen production process, Hydrogen combustion I.C Engines, Hydrogen combustion and fuel cells, Experiment on Proton Exchange membrane, experiments of solid oxide Fuel Cell materials.

Suggested Readings

1. Corbo, P., F. Migliardini, and O. Veneri. 2011. Hydrogen Fuel Cells for Road Vehicles. 1st Ed. Springer-Verlag London Limited.
2. Stolten, D. and B. Emonts. 2012. Fuel Cell Science and Engineering, Vol-I. Wiley-VCH Verlag & Co. KGaA, Weinheim. Germany.
3. O'Hayre, R.P., S.W. Cha., W. Colella and F.B. Prinz. 2009. Fuel Cell Fundamentals, 2nd ed. John Wiley & Sons, New York. USA.
4. Bejan, A. 1988. Advanced Engineering Thermodynamics, 2nd Ed. John Wiley & Sons, USA.
5. Heywood, J.B. 1988. Internal Combustion Engine Fundamentals, 1st Ed. Mc Graw Hill Education, USA.
6. Hoogers G. 2002. Fuel Cell Technology Handbook, 1st Ed. CRC Press and SAE International. USA.
7. Larminie J. and A. Dicks. 2003. Fuel cell systems explained, 2nd Ed. John Wiley and Sons, England.
8. Repeat reference (37/28).
9. Repeat reference(37/28)
10. Li, X. 2006. Principles of Fuel Cells, 1st Ed. Taylor & Francis Group, New York. USA..
11. Blomen, L.J.M.J. and M.N. Mugerwa. 1993. Fuel Cell Systems, 1st Ed. Plenum Press, New York. USA.
12. Stanford Univ. Lecture series on fuel cells, solar cells, batteries, capacitors, etc

ESE-	Bioenergy Engineering	4(3-1)

Objective

To help the students in learning the basic concepts of different renewable energy systems related to biogas, bio-diesel and biomass.

Contents

Overview of various types of renewable and non-renewable energy resources, Energy reclamation from agricultural crops/wastes, Different biomass for energy production, Different components and efficiency calculation of biomass fired boilers, Biogas, various types of biogas plants. Design, installation, operation and management of fixed dome and floating drum biogas plants, Power generation from biogas plants, Concept of CHP in energy production, Introduction, types, design, development and evaluation of gasifies for heat and power generation.
Introduction, different crops for bio fuels, Chemical composition of bio-diesel, bio-diesel production in laboratory and at commercial scale.

Practical

Demonstration of different components of bio gas plant; Design and development of different sizes of fixed dome and floating drum type biogas plants, Performance evaluation of biogas plants; Energy production and efficiency calculation from biomass using steam boilers and gasifiers; Laboratory method to Produce of bio-diesel from vegetable and plants oils.

Suggested Readings

1. Vertes, A.A., N. Qureshi., H.P. Blaschek. And H.Yukawa. 2010. Biomass to Biofuels: Strategies for global Industries. 1st Ed. John Wiley & Sons, Ltd. USA
2. Soetaert, W. and E.J. Vandamme. 2009. Biofuels, Kindle Ed. John Wiley & Sons, UK..
3. Dieter, D. and A. Steinhauser. 2011. Biogas from Waste and Renewable Resources: An Introduction, 2nd Ed. John Wiley & Sons, USA..
4. Brian, H. 1996. Power plants: Biofuels made simple. Centre for Alternative Technology. Wales.
5. Patterson, W.C. 1994. Power from Plants: The Global Implications of New Technologies for Electricity from Biomass. Royal Institute of International Affairs Energy and Environmental Programme and Earthscan, London..

ESE-	RS & GIS for Renewable Energy Resources	3(2-1)

Objective

To relay essential concepts relating to geographical information systems such that candidates can use RS & GIS software independently, efficiently and meaningfully in support of resource assessment and site identification studies for renewable energy projects.

Contents

Introduction: What is RS & GIS?, Example applications of RS & GIS, Coordinate systems and projections, Scale generalization and geo-referencing, Representing the real world using spatial data., Representing the real world using spatial data. II, Sources of spatial data, Terrain analysis and assessment, Spatial data analysis and prediction, Spatial statistics, MapInfo Workshops, Installation, MapInfo definitions, Open existing tables, Creating new tables, Drawing objects on a map, Raster coverage's Universal translation of file formats, Spatial queries, Table menu functionality, Changing options and preferences, Creating and using layouts.

Practical
To determine coordinate systems and projections of different potential energy sites; To determine solar radiation from satellite imagery; To devise procedure of terrain analysis and its assessment; To identify the potential sites for setting of various renewable energy production units.

Suggested Readings

1. Burrough, P.A. and R.A. McDonnell. 1998. Principles of geographical information systems, 2nd Ed. Oxford University Press, Great Britin.
2. DeMers, M.N. 2005. Fundamentals of geographic information systems, 3rd Ed. John Wiley, New York.
3. Heywood, I., S. Cornelius. And S. Carver. 2012. An introduction to geographical information systems, 4th Ed. Prentice Hall, UK.
4. Longley, P.A., M. Goodchild., D.J. Maguire and D.W. Rhind. 2005. Geographical information systems and science, 2nd Ed. John Wiley & Sons, Chichester..

ESE-	Heating Ventilation and Air Conditioning Systems	4(3-1)

Objective
To train the students about the design, development and parametric analysis of solar thermal cooling systems.

Contents
Introduction, definition and basic terminology, refrigeration cycle, vapor compression cycle, COP, introduction to pressure-enthalpy chart, types of refrigerants, air cycle refrigeration, vapor absorption refrigeration and air conditioning, working principle of thermally driven cooling machines, single, double and triple effect absorption chiller, adsorption chiller, desiccant evaporative cooling, ejector cycle, indoor and outdoor air conditions, comfort air conditions and comfort zone, indoors air quality, psychrometry, psychometric chart and psychometric properties, central air conditioning system, essential components of central air conditioning plant, water chiller and water heater, air handling unit, chilled water and hot water re-circulating system, return air supply system, fresh air supply system and air mixture chamber, supply fan, air dust cleaning and bacteria removal, air supply and air return terminals, diffusers, dampers, grillers and registers, CFM rating and tons of air conditioning of central air conditioning plant, cooling and heating loads, calculation procedures, duct sizing and piping design, pumps and fans selection, air ventilation, calculation of fresh air supply of multi-story buildings, air handling units for treatment of fresh and return, dust and bacteria removal methods,

forced convection based air ventilator design, cooling towers, hydronic terminal units. Economics of solar cooling systems.

Practical

To find the co-efficient of performance of vapor compression cycle using general cycle refrigeration trainer; To determine the thermodynamics properties of air by using the psychometric chart; To represent refrigeration cycle on pressure enthalpy diagram; To calculate the degree of sub-cooled in condenser; To calculate degree of sub-cooled in liquid line; To calculate degree of super heat in the evaporator; To calculate the heat transfer rate; To determinate the rate of heat transfers from the air; To determinate the rate of heat transfers from the heater; To calculate the rate of heat absorbed in the evaporator at different cooling load; To demonstrate the operation and function of each component of heat pump; To understand the effect of cooling load to the sub cooled; To understand the effect of cooling load to the super heat; To understand the effect of cooling load to compression ratio.

Suggested Readings

1. Circle, T. and N.E. Atlanta. 1997. ASHRAE, Handbook - Fundamentals, SI Edition, American Society of Heating, Refrigerating and Air-Conditioning Engineers. USA.
2. Duffie, J.A. and W.A. Beckman. 1991. Solar Engineering of Thermal Processes, 2nd Ed. John Wiley & Sons, USA.
3. Kreith, F. and J.F. Kreider. 1978. Principles of Solar Engineering, 2nd Ed. McGraw-Hill, New York.
4. Kreider, J.F. and F. Kreith. 1981. Solar Energy Handbook. 2nd ED. McGrawHill, New York USA.

ESE-	Energy Conservation	3(3-0)

Overview of Pakistan's Energy Scenario, Fundamentals of Energy Engineering, Energy Auditing, Energy Efficiency in Motor drive Systems, Cogeneration Efficiency in Boilers and Steam Systems, Infrared Thermography for Energy Applications Energy Conservation in Buildings, Energy Conservation using Heat Pumps, Industrial Applications of Solar Thermal, Energy Economics, Efficiency Conservation in Pumping/Compressed Air, Pinch Analysis, Energy Efficient Lighting, Waste Heat Recovery, Benchmarking Energy Performance, Energy and Climate Change and CDM, Laboratory Experiments- Boiler, Motor Efficiency , Lighting, Pumping Control, visits to different industries etc.

Suggested Readings

1. Eastop, T.D. and D.R. Croft. 1990. Energy Efficiency for Engineers and Technologists. Logman Scientific & Technical.
2. Reay, D.A. 1977. Industrial Energy Conservation, 1st Ed. Pergamon Press, NewYork..
3. Witte, L.C., P.S. Schmidit. And D.R. Brown. 1988. Industrial Energy Management & Utilization, 1st Ed. Springer.

ESE-	I.C. Engines	3(2-1)

Objective

Providing instructions relating components of IC engine, tractor components and its mechanics.

Contents

Introduction: History of engine development, engine cycles, principles of operation, types of engines.

Principal parts of engine: Functions, construction, cylinder, cylinder heads, liner, crank case, piston, connecting rod, crank shaft, clutch, flywheel, valves and their operation, valve mechanism.

Fuels and combustion: Types of engine fuels, fuel tests and their significance, gasoline tests, antiknock test, octane number, volatility, Reid vapour pressure, sulphur content, gun content, heat values, gasoline additives. Engine emissions and their analysis.
Fuel System: major components of fuel systems (petrol / diesel), carburettor, fuel injection pump, injector/nozzles, electronic fuel injection, governing system, trouble shooting, calibration of fuel injection pump.

Ignition system: Types of ignition, spark, magneto and compression ignition, induction coils, distributor, spark plug, contact-breaker points, condenser, trouble shooting.

Cooling system: Types, principle of operation, parts of air/water cooling system, line diagram, radiator, thermostat, water pump, fan, engine heating, repair and maintenance, types of coolants.

Lubrication system: Types, principle of operation, components of lubrication systems, line diagram, types of lubricants, trouble shooting.
Electrical System: AC and DC voltage, alternator/dynamo, battery, battery charging and maintenance, self-starter, electrical gauges and controls, line diagram, repair and maintenance.

Intake and exhaust system: Air intake system, air cleaner, super charger, turbo charger, inter-cooling, and construction of intake and exhaust manifolds, mufflers, flue gases.

Mechanics of the Farm Tractor Chassis: Force Analysis, Soil reaction, Draw bar pull, Stability of tractors, Tipping and lateral stability. Clutch and Brakes: Transmission, Differentials, Power take-off, Pulley drives, Power lift and hydraulic controls. Tractors tests and performance. Farm Management: Farm planning for efficient use of resources and attainment of business goals and farm accounting.

Practical

Study of main components of engine and engine types; Study of valve system and its adjustments; Demonstration of fuel system, cooling system and electrical system of tractor.; Measurement of air pressure/air fuel ratio in each cylinder of engine; Fuel injector, pump adjustment and calibration; Demonstration of engine lubrication system; Servicing of a single cylinder diesel engine; Removal of air lock of a diesel engine; Battery testing for charging/discharging; Engine diagnostics-analysis of engine emissions using gas analyzer, multi-scan, etc.; Tour to tractor industry (Millat Tractors Limited, Al-Ghazi Tractors, Ltd).

Suggested Readings

1. Single, R.K. 2004. Internal Combustion Engines. S.K. Katana & Sons. New Dehli, India.
2. Jain, S.C. and C.R. Rai. 2000. Farm Tractor Maintenance and Repair, Tata McGraw Hill Publishing Company Limited, New Delhi.
3. Halderman, J.C. and D. Mitchell. 2005. Automotive Engines: theory and servicing, 5th Ed. Pearson Prentice Hall, Singapore.
4. Promersberger and Bishop. 1996. Farm Power. Prentice Hall Inc. Englewood Cliffs, New Jersey. USA.
5. Paul, W.G., S. James.and E.J. Ziruys. 1995. Fundamentals of Internal Combustion Engines, 4th Ed. Oxford & IBH Publishing Company (Pvt) Ltd, New Dehli..

ESENG-	Project & Report-I	3(3-0)

Objectives

To provide experience of working as part of a project team of 4 to 6 in a situation close to that which might be found in an industrial or commercial setting. To apply knowledge and skills, at the forefront of the renewable energy discipline, obtained from taught modules and independent learning to a real engineering situation at a professional level and as part of a team effort. To integrate knowledge gained in

several areas of the degree course. To encourage the use of initiative, imagination and creativity applied in the context of a team effort. The project topic is product design orientated.

Contents

Introduction to technical report writing, important components of technical writing, selection/preparation of research topic, objectives, review of literature, methodology, data processing, results, conclusions, summery, abstract, presentation of (data collected in the field/laboratory) results in the form of graphs, tables, figures, and photographs, references and appendices, report writing, presentation methods and skills.

Suggested Readings

1. Awan, J.A. 2004. Technical writing, University of Agriculture press, Faisalabad.

ESE-	Power Electronics	3(2-1)

Learning Objectives:

To provide adequate Knowledge and clear understanding about the construction, principle of operation, characteristics, protection, problems and applications of various Power electronic Semiconductor devices and their Control Circuits.

Contents:

Introduction: Recent advancement in Power Electronics and its Application, Power diodes, Freewheeling diodes Diodes with RC and RL ,LC and RLC loads. Types of Power transistors and their Characteristics. The thyristor: Principle of operation, characteristics, two transistor model of SCR, Thyrister types, Ratings, Protection and cooling, Thyristor Turn-on and Turn off , Commutation techniques, Series and Parallel operation of thyristors, Thyristor firing circuits.

Static switches: Single phase and three phase A.C switches, Three phase reversing switches, AC switches for bus transfer, DC switches, Solid state relays, Design of static switches.

Thyristor converters: AC voltage controllers, controlled rectifiers, Inverters, DC link converters, DC Choppers, Cyclo converters.
Solid state drives: Thyristor starting and speed control of Induction motors, Direct current motors and synchronous motors, Brushless excitation system. Applications and problems: Applications of power electronics, Harmonics generation types and their problems. Analysis of harmonics and their remedial methods.

Practical
Practical/Simulation work is based on the above theoretical course

Suggested Readings:

1. Rashid, M.H. 2013. Power Electronics Circuits, Devices and Applications, 4th Ed. Prentice Hall, India.
2. Bimbhra, P.S. 2012. Power Electronics, Latest Ed. Khana Publishers, Delhi. India.
3. Lander, C.W. Power Electronics. McGraw Hill, Latest Edition..

ESE-	Energy Economics, Policy and Management	3(3-0)

Introduction and Background, Review of the Basics of Supply, Demand and Price Formation in Competitive Markets, Energy Demand: Short Run and Long Run Price and Income Elasticities, Introduction to Multivariate Regression Analysis, Energy Supply and the Economics of Depletable Resources, World Oil Markets and Energy Security, Natural Gas Price Regulation, Deregulation and Markets, Electricity, Risk Management, Futures Markets and Derivatives, Energy and Climate Change Internalizing Environmental Externalities with a Focus on CO_2 Emissions Cap and Trade Mechanisms.
Coal, Nuclear Power, Energy Efficiency Policies, Renewable Energy Policies, Life cycle cost analysis of energy systems.

Suggested Readings

1. Pindyck, R. and D. Rubinfeld. 2005. Microeconomics. 6th Ed. Upper Saddle River, NJ: Prentice Hall.
2. Carol A. Dahl. 2004. International Energy Markets: Understanding Pricing, Policies, and Profits. 2nd Ed. Tulsa: Pennwell.
3. Ayres, R.U. and E.H. Edward. Crossing the Energy Divide: Moving from Fossil Fuel Dependence to a Clean-Energy Future.
4. Bern, G. Investing in Energy: A Primer on the Economics of the Energy Industry. Wiley and Sons. USA.
5. Duffie and Beckman. 2010. 4th Ed. Solar Thermal Engineering. Wiley and Sons. USA.

ESENG-	Project & Report-II	3(0-3)

Objective
To provide experience of working as part of a project team of 4 to 6 in a situation close to that which might be found in an industrial or commercial setting. To apply knowledge and skills, at the forefront of the renewable energy discipline, obtained from taught modules and independent learning to a real engineering situation at a professional

level and as part of a team effort. To integrate knowledge gained in several areas of the degree course. To encourage the use of initiative, imagination and creativity applied in the context of a team effort. The project topic is product design orientated.

Contents
Introduction to technical report writing, important components of technical writing, selection/preparation of research topic, objectives, review of literature, methodology, data processing, results, conclusions, summery, abstract, presentation of (data collected in the field/laboratory) results in the form of graphs, tables, figures, and photographs, references and appendices, report writing, presentation methods and skills.

Suggested Readings
1. Awan, J.A. 2004. Technical writing. University of Agriculture press, Faisalabad, Pakistan..

List of Contents of Engineering Elective Courses

ESE-	Renewable Energy Engineering	3(2-1)

Objective
An introductory course introducing concepts of energy and renewable energy sources.

Contents
History of energy usage, forms of energy, present energy consumption, environmental problems Conventional energy sources: energy and power; fossil fuel and nuclear, Solar thermal energy:- Solar radiation resource, passive and active solar heating, solar concentrators. Solar photovoltaic:- Basic PV operation, PV technologies, electrical characteristics Biomass:- Definitions, biomass resource, extracting biomass energy, fuel crops, anaerobic digestion, landfill gas, waste to energy, energy balances and economics. Hydroelectricity:- the resource, hydropower power equation, turbines, large and small scale systems, pumped storage.

Tidal Power:- The tides, tidal resource, system operation, environmental factors Wind energy:- generation of the winds, wind resource, basic aerodynamics (lift versus drag) and the fundamental power equation; fundamental design concepts.
Wave energy:- The wave resource, the fundamental power equation; onshore and off-shore wave energy extraction systems.

Geothermal Energy:- Introduction, nature of fields, Classification of Geothermal Resources, Introduction to geothermal steam electric plants, Liquid Dominated System: Flashed Steam System, Total Flow Concept, Geothermal exploration

Fuel Cell:- Introduction and Classification, Reactions and Configurations, Phosphoric Acid Fuel Cell, Molten Carbonate Fuel cell (Construction, Working, Advantages and Disadvantages), Solid Oxide Fuel Cell (Construction, Combined Cycle Schematics, Advantages, Limitations), Solid Polymer Fuel Cell (Construction, Applications, Membrane Properties)

Nuclear Physics Review: Nuclear structure; Nuclear stability; Binding energy and mass-energy equivalence; Radioactivity (natural and artificial); Decay rate; Mean-life and half-life; Radioactive equilibrium; Nuclear Reactions;; Fission reaction; Elastic and inelastic scattering reactions. Neutron reaction; Neutron flux; Cross section for scattering, absorption and fission Reactor Theory: Nuclear chain reactors; Criticality; The four factor formula; One group critical equation; The critical size, Reactor Kinetics: Types of Nuclear Reactors: Introduction, Pressurized Water Reactor (PWR), and Primary Loop, Pressurize, Chemical Shim Control.

Practical

Measurement of beam, diffuse and total solar radiations using Pyranometers; Determination of Voltage and Amperage of PV modules using AVO meters; Performance evaluation of biomass boilers by direct and indirect methods; Determining hydropower equations using impulse turbines; Determining the physical basics of wind energy transformation.

Suggested Readings

1. Boyle, G. 2004. Renewable Energy: Power for a Sustainable Future, 2nd Ed. OUP and Open University.
2. Boyle, G., B. Everett, and J. Ramage. 2004. Energy Systems and Sustainability, 2nd Ed. OUP and Open University.
3. Scheer, H. 2004. A Solar Manifesto. 2nd Ed. Hermann Scheer.
4. Kalogirou, S.A. 2009. Solar Energy Engineering: Processes and Systems. 1st Ed. British Library Printed in USA.
5. Viswanathan, B. and M.A. Scibioh. 2007. Fuel Cells: Principles and Applications. Taylor & Francis Group. USA.

ESE-	Petroleum and Gas Exploration	3(2-1)

Contents

Historical over view of discovery and exploitation of petroleum and its products. Physical and chemical properties of petroleum. Introduction to petroleum geology. Methods of exploration. The sub-surface environment. Generation and migration of petroleum. Well-drilling and prediction. Reservoir characterization. Traps, sedimentary basins, reservoir production methods. Production modeling and simulation.

Gas treating processes, process description of gas treating unit, review of liquid solvent treating of gases, process calculation for an amine contactor and combating degradable impurities in methyl, ethyl amine gas treating.

Practical: Practical related to the topic covered in theoretical part and fields visits.

Suggested Readings

1. Michael, J. Petroleum Production Systems. 2nd Ed. Prentice Inc. Hall, USA. .
2. Gatin, C. Petroleum engineering drilling and well completion. 1st Ed. Prentice Inc. Hall. New Jersey, USA.
3. David, A.T., Donobu, and K. R.Laug. 1986. A first course in Petroleum Technology, International Human Resources Development Corporation .
4. Levorsen, A.I. 2001. Geology of Petroleum. 2nd Ed. The AAPG Foundation, USA..
5. William, D. 2011. Properties of petroleum fluids, 2nd Ed. Pennwell, USA..
6. Mitohell, R.F. 2011. Drilling Engineering. 2nd Ed.

ESE-	Geothermal and Tidal Energy	3(2-1)

Contents:

Geothermal Energy: Geology of Geothermal Regions, Exploration Strategies and Techniques Principles, heat source systems for ambient air utilization, heat source systems for shallow geothermal utilization, Geothermal well drilling, design of down hole part, up hole part, district heating system, environmental analysis of geothermal energy. Case study related to geothermal energy, Single and double Flash Steam Power Plants, Binary Cycle Power Plants, Advanced Geothermal Energy Conversion Systems, Exergy Analysis Applied to Geothermal Power Systems; Tidal and Wave energy, Tidal and Wave Energy Conversion Systems,

Practical

Laboratory demonstration of Heat source systems; demonstration f well drilling techniques; case study for exploring geothermal resources; Demonstration of tidal and wave behave using computer applications; visits of Geothermal plants, visit of Tidal and wave regions.

Suggested Readings

1. Pimental, D. and R. DiPippo. 2008. Geothermal Power Plants, 2nd Ed. Elsevier. USA.
2. Gupta, H. and S. Roy. 2007. Geothermal Energy – An Alternative Resource for the 21st Century, 1st Ed. Elsevier, USA.
3. Tabak, J. 2009. Solar and Geothermal Energy 1st Ed. Facts On File.
4. Charlier, R.H. and W.Finkl. 2009. Ocean Energy Tide and Tidal Power. 1st Ed. Springer.
5. Brooke, J. 2003. Wave Energy Conversion. 1st Ed. Vol- 6. Elsevier Ocean Engineering Series.

ESE-	Fuel and Combustion	3(2-1)

Contents

Classification of fuels, chemical composition and chemistry of fossil fuels, physical-chemical properties of fossil fuels, (Density, Volatility, Viscosity, Ignition, calorific value, poor flash and colour, purity), Combustion phenomena of common fuels. Ignition and flame stabilization detection, monitoring and control, practical applications of fuel and common technologies, combustion generated pollutants and control. New fuels, fuel testing and specification of commercial fuels. Calculation of the composition of products from the combustion of gaseous, liquid and solid fuels, flue gas analysis (proximate and ultimate analysis), boiler heat balance, heating values of fuels (lower heating values and higher heating values). Advantages and disadvantages of gaseous fuels, Combustion of Hydrogen, Carbon, Hydro Carbon and Sulphur, Air fuel ratio, Losses in burning fuels. Efficiency of combustion systems.

Practical

Identification of different types of fuels; determination of C, H2, S, O2 in the fuel using fuel analyzer; determination of combustible gases using Orsat and electronic gas analyzer; Determination of calorific value of different fuels using oxygen bomb calorimeter; performance evaluation of combustion power plants.

Suggested Readings

1. Gupta, S. 1999. Fuel & Combustion, Springer.
2. Sarkar, S. 2009. Fuel & Combustion. 3rd Ed. Orient Black

Swan, Telangana, India.
3. Dara,S. Engineering Chemistry.
4. Khurmi, R.S. 2006. Thermal Engineering. 15th Ed. Chand (S.) & Co Ltd , India.
5. Joel, R. 1997. Basic Engineering Thermodynamics. 5th Ed. Prentice Hall.

ESE-	Environmental Impact Assessment	3(3-0)

Contents

Introduction: EIA as a Tool for Sustainable Development, Process and Framework for EIA, Guidelines and Legal Aspects, Environmental Settings, Methodologies of EIA, Assessing Regional and Sectoral Level Impacts, Computational Modeling, GIS Applications, Knowledge Based Expert Systems and Soft computing Applications, Environmental Management Plan, Challenges in Preparation of EIA Reports, Case Studies of Engineering Projects , Future of EIA in Pakistan: Status, Problems and Remedial Actions

Suggested Readings

1. Trivedi, P.R. 2004. Environmental Impact Assessment. 1st Ed. APH Publishing Corporation New Delhi, India.
2. Petts, J. and W. Christopher. 1999. Environmental Impact Assessment: Impacts and Limitations. 1st Ed. Wiley Blackwell, UK.
3. Morris and Peter. 2009. Methods of Environmental Impact Assessment. 3rd Ed. Routledge London, UK.

ESE-	Theory of Machines	3(2-1)

Learning Objectives

1. To develop the ability to analyze and understand the dynamic (position, velocity, acceleration, force and torque) characteristics of mechanisms such as linkages and cams.
2. To develop the ability to systematically design and optimize mechanisms to perform a specified task.
3. To effectively integrate computer simulations and analysis into the mechanism design process.
4. To increase the ability of students to effectively present written, oral, and graphical solutions to design problems.
5. To increase the ability of students to work cooperatively on teams in the development of mechanism designs.
6. To make connections between design theory, computer simulations and actual performance through the construction and testing of working prototypes.

Contents

Introduction to Mechanisms, Degrees of Freedom, kinematic diagrams, Degrees of Freedom, Grashof types, Introduction to linkage design, Inversions and graphical synthesis, measures of design quality including transmission angles and circuits, coupler curves, Graphical velocity analysis, Instant centers, mechanical advantage, Instant Centers in complex mechanisms, instant centers in design, Graphical acceleration analysis, Forces in Mechanisms linkage analysis and design, Introduction to cams – terminology, pressure angles, SVAJ diagrams, sizing a cam, introduction to DYNACAM, Cam performance equations, Gears: Terminology, simple, compound and reverted gear trains, introduction to planetary gear trains, Transmissions, differentials, planetary gears.

Practical

Static and dynamic balancing; portable governors, Hartnell Governor; Spring Type Governor; Whirling of Shafts; Gyroscopic motion; Links mechanism; Fly wheels; Bearings frictions

Suggested Readings

1. Norton. 2009. Design of Machinery. 2nd Ed. McGraw-Hill.
2. Mott, R.L. 2003. Machine Elements in Mechanical Design. 4th Ed. Prentice Hall.
3. Hamrock, B. J., S.R. Schmid. and B. Jacobson. 2004. Fundamentals of Machine Elements. 2nd Ed. McGraw-Hill Series.

ESE-	Nuclear Energy Engineering	3(3-0)

Contents

Role and importance of nuclear energy, Particle wavelength, Excited states and radiation, Nuclear stability and radioactive decay, Nuclear reaction, Binding energy, Radioactive decay,
Interaction of radiation with matter:

Neutron interaction, Cross-sections, Neutron attenuation, Neutron flux, Neutron cross-section data, Energy loss in scattering collision, Fission, γ-ray interaction with matter
Nuclear reactor: Fission chain reaction, Nuclear reactor fuel, Nuclear power plants Nuclear Reactor Systems and components:

Steam generator, Pressurizer, Steam supply system, Reactor Containment, Turbine, Cooling Tower; Nuclear reactor theory: Neutron flux, Fick's law, Equation of continuity, Diffusion equation, heat Removal from reactor, Heat generation in reactors, Conduction, Convention, Two

Phase Flow, Boiling Heat transfer, Nuclear reactor safety :Reliability, Risk, Safety

Suggested Readings

1. Lamarsh, J.R. and A.J. Baratta. 2001. Introduction to Nuclear Engineering. 3rd Ed. Prentice Hall.
2. Lewis, E.E. 2008. Fundamentals of Nuclear Reactor Physics. 1st Ed. Academic Press. USA.
3. Murray, R.L. 2009. Nuclear Energy: An introduction to the concepts, systems and applications of nuclear processes. 6th Ed. Elsevier Inc.
4. Knief, R.A. 2008. Nuclear Engineering Theory and Technology of Commercial Nuclear Power. 2nd Ed. American Nuclear Society. USA.

ESE-	Nano Technology and Energy	3(3-0)

Contents

Introduction to Nano Technology, Characteristics of Nano material, Nano particles, Bucky balls, CNTs and quantum dots, super capacitors, lithium ions battery, Hydrogen storage, Nano catalyst for optimized fuel production, Dye sensitized solar cell, quantum dot solar cell, semi-conducting Nano-materials and photo catalyst, metal oxides and sulfides for hydrogen production, limitation of existing photo catalyst, Introduction conducting polymers, organic light emitting diodes, conducting polymers solar cells.

Suggested Readings

1. Wilson, M., K. kannangara, B.Raguse, and M. Simmon. 2002. Nano technology: basic Science and emerging technologies. 1st Ed. Chapman and Hall/CRC.
2. Garcia-Martinez, J. 2013. Nanotechnology for energy challenge. 2nd Ed. Wiley-VCH.
3. Somorjai, G.A., H. Frei, and J.Y. Park. 2009. Advancing the frontries in nanocatalyst, biointerfaces and renewable energy conversion by innovations of surface techniques.

ESE-	Clean Coal Technology	3(2-1)

Role of coal in the overall energy situation. Recent advances in coal preparation methods including fine coal treatment. Geology of coal, Coal Classification, Ground control, Room and Pillar method, Long and Short wall mining, Haulage system, Surface mining and coal utilization. Properties of coal and impurities in relation to preparation; sampling of coal; coal characteristics and their relationship to utilization, wash ability

studies and evaluation of coal for different uses; the economics of coal preparation; raw coal handling, breaking and crushing; screening, wet concentration methods of coarse coal; wet concentration methods of fine coal; dry concentration, mechanical & thermal dewatering, status & scope of coal preparation by flotation. Dust collection in coal processing and handling. Coal storage and loading plant waste.Thermodynamics and kinetics of coalgasification reactions. Fluidized bed coal gasification processes. Coal liquefaction: various methods, kinetics of solvent extraction, catalytic hydrogenation and other liquefaction processes. Concept of coal refinery and coalplex. Environmental impact analysis of coal utilization methods such as carbonization, gasifier, etc.

Practical: Practical related to the topics covered in part of the course.

Suggested Readings

1. Stefanco, R. 1998. Coal Mining Technology. 1st Ed. Springer.
2. Low oil coal technology.
3. Berkowitsz, N. 1979. An introduction to coal technology. 2nd Ed. Academic Press. USA.
4. Mason. 1956. Coal Mining. 1st Ed. Virtue & Co. London, UK.
5. Hartman. 2002. Introduction to Mining Engineering. 2nd Ed. Wiley..

ESE-	Machine Design	3(3-0)

Learning Objective

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

Contents

Meaning of Mechanical Engineering Design, Phases of design, Design considerations, Safety and product reliability, Codes and standards, evaluation and presentation.

Design of shafts, torsion of circular shafts, horsepower transmitted by the shafts, design of clutches, bearings, gears, flange couplings, pulleys and connecting rod.Different types of fasteners. Thread standards and definitions, Mechanics of power screws. Bolts strength and selection of units, Bolt preload, torque requirement, Bolted, riveted and welded joints loaded in shear, Keys pins, and retainers. Belts, Stresses in belts, Chain and sprocket drives, Gears drives, Flexible shafts, Bearings.

Suggested Readings

1. Shigley, J.E. and C. R. Mischhe. 2000. Mechanical Engineering Design. 5th Ed. McGraw Hill Publications Inc. USA.
2. Parkinson, A.C. 1968. A First Year Engineering Drawing, 6th Ed. Sir Issac Pitman & Sons Ltd. London, UK.
3. Spotts, M.F. 2003. Design of Machine Elements. 8th Ed. Englewood Cliff Prentice Hall. London, UK
4. Yoshimi, I. 2008. Modular design for machine tools. 1st Ed. Library of Congress cataloging .USA.

MATH-301	Linear Algebra & Calculus	3(3-0)

Objective
To learn fundamentals of algebra & calculus.

Contents
Basic set theory: Complex numbers: Cartesian and polar form, De Moivre's theorem, roots, exponential, trigonometric, hyperbolic and logarithmic functions', complex powers. Matrices: square matrices, determinants, reduced echelon form, rank, eigen-values, eigen-vectors, Markov processes, mass transient problem, forecasting of weather and develop the solution of system of differential equations for mechanical systems/electrical systems/agricultural/civil engineering especially in public health engineering problem, linear transformation, modeling and solution of system of linear equations.

Vector spaces: group, subgroup, ring, field, vector space, subspace, linear independent and linearly dependent set of vectors, spanning set, basis for a vector space and its applications in engineering.

Differential calculus: limit, continuity, derivative, total differential, higher order differentiation, tangent and normal, Taylor series, Maclaurin series, extreme values, 1st and 2nd derivative test, point of inflection and its applications in business and engineering.
Integral calculus: limit of sum, Riemann integration, evaluating integrals, definite integrals, area under a curve and other applications of integration.

Suggested Readings

1. Kreyszig, E. 2000. Advanced Engineering Mathematics. 8th Ed. John Wiley and Sons. New York. USA.
2. Yusuf, S.M. and M. Amin. 2002. Mathematical Methods, Ilmi Kitab Khana, Kabir Street Urdu Bazar, Lahore.

3. Thomas, G.B. and R.L. Finney. Calculus and Analytical Geometry. 2002. 9th Ed. Roohani Press, Islamabad. Pakistan.

PY-301	Applied Physics	3(2-1)

Electricity and Magnetism: Voltage, current, resistance, power, single phase and 3- phase A.C. supply. Series and parallel circuits. Vector addition and subtraction of A.C. voltages. A.C/D.C. motors: Concept of rotating fields, polyphase induction motor, lap and wave winding of single phase and three phase motors, torque and starting characteristics,measuring instruments, transformers. A.C power generators. Electrical distribution and wiring for farm buildings. Electric controls, motor controls, and protection. Selection of farm motors, applications of electricity at farm. Electronics: Semi-conductors, PN-junction; Transistor; its characteristics and uses; Amplifiers; Power supplies; Magnetism: Electro-Megnetic induction and radiation; Radioactivity: Radio isotopes; Biological effects of radiation; Laser: Introduction, generation and uses of Laser. Fiber optics–characteristics.

Practical

1. Construction of wiring systems, fuses, switches of various types insulators.
2. Circuits design and drawing of a typical farm electrical system.
3. Selection of motor for various farm equipment such as forage cutter, feed-grinders, and shop tools.
4. Practice on repair and adjustment of electric motors, switches, fuses, transmission wiring controls.
5. Study of 3 phase induction motor.
6. Study of star and delta connections.
7. Study of semi conductor, triode, diode valve and transistors.
8. Use of AVO meter, CRO, plani meter.
9. Fabrication of full wave rectifier and inductance study of its wave-shape.
10. Measurement of self inductance and mutual inductance.

Suggested Readings

1. Theraja, B.L. 2004. A Text Book of Electrical Technology. 23rd Ed. S. Chand & Co. Ltd. New Delhi, India.

2. Fitzgeraid, A.E. 1981. Basic Electrical Engineering 5th Ed. McGraw Hill, New York USA.
3. Hammond, P. 1986. Electromagnetism of Engineers. 3rd Ed. Pergamon Press. New York, USA.

CS-401	Computer Programming and Applications in Engineering	3(2-1)

Contents

Introduction: Computer components, operating system, software & applications, Programming: Introduction, programming languages, flowchart, programming structure, introduction to C++, application of C++ to solve engineering problems, modeling and simulation.

Practical

1. Demonstration of computer components and Windows installation.
2. Exercise on the use of word processing, spreadsheet and engineering graphics.
3. Programming of engineering problems with C++.

Suggested Readings

1. Perry, G. and M. Johnsons. 1992. Turbo C++ by Examples. Prentice Hall Computer Publishing. New York, USA..
2. Shelly and Cashman. 1995. Using Computer, a Gateway to Information. 2nd Ed. Boyd and Fraser Publishing Company, USA.

MATH-401	Differential Equations, Power Series, Laplace Transform	3(3-0)

Contents

Ordinary Differential Equation: Basic concepts of ordinary differential equation, General and particular solution, Initial and boundary condition, Linear and nonlinear differential equations, Solution of first order differential equation by separable variables and its application in our daily life situations, Techniques like change in variables homogeneous, non-homogeneous, exact, non-exact, linear and non-linear Bernoulli could be used in case of complications. Solution of second order differential equations by theory of operators and its application as forced and free oscillations, the extension of second order solution criteria to high order differential equations, solution of the system of differential equations by theory of operators and its application in daily life situations. Partial Differential Equations: Basic Concepts, linear and non-linear P.D equations, Quasi linear and Quasi non-linear P.D equations, homogenous and non-homogenous P.D equations, solutions of P.D equations, boundary and initial conditions as dirichlet conditions, Neumann' s condition, Robbin's/mixed condition, classification of P.D equations as Elliptic conditions, Parabolic and hyperbolic. Analytic Solution by separation of Variables of the Steady State, two dimensional

heat equation/Laplace equation and un-steady one dimensional heat equation/Diffusion equation with homogenous and non-homogenous boundary conditions. D'Alembert's solution of two dimensional wave equation homogenous and non-homogenous boundary conditions. Fourier Series: Periodic waveforms and their Fourier representations, calculating a Fourier series, Fourier series of odd and even functions, Half range Fourier series, Fourier series solution for the above P.D equations.

Suggested Readings

1. Kreyszig, E. 2011. Advanced Engineering Mathematics. 10th Ed. John Wiley and Sons. New York, USA.
2. Yousaf, S.M. 1998. Mathematical Methods, Ilmi Kitab Khana Kabir Street, Urdu Bazar, Lahore, Pakistan.
3. Sharma, G.S., K.L. Auhuja and I.J.S. Sarna. 1988. Advanced Mathematics for Engineers and Scientists. Tata McGraw Hill Co, India.

SSH-102	Pakistan Studies	2(2-0)

Contents

Historical Perspective: Two nation Theory; Ideology of Pakistan; Objectives for the creation of Pakistan; Important personalities in the creation of Pakistan; Sir Syed Ahmad Khan; Allama Iqbal; Quaid-e-Azam. Constitutional Development in Pakistan: Objectives Resolution and its constitutional importance; Ulma's 22 points; Islamic provisions of 1956 constitution; Islamic provisions of 1962; Constitution; Islamic provisions of 1973 constitution. Contemporary Pakistan: Objectives of Pakistan's foreign policy; An overview of Pakistan's foreign Policy; Pakistan's foreign policy towards her neighboring countries; Regional organizations.

Suggested Readings

1. Amin, S. 2010. Pakistan's Foreign Policy, Oxford University Press, Karachi.
2. G, Allana. 2010. Our Freedom Fighters, Ferozesons Pvt. Ltd. Lahore, Pakistan.
3. Hussain., Anjum, and Zahid. 2010. Encyclopedia of Pakistan. Jahangir Book Depot, Lahore, Pakistan.
4. Khan, H. 2010. Constitutional and Political History of Pakistan. Oxford University Press, Karachi, Pakistan.
5. Mehmood, S. 2010. International Affairs, Jhangir Book Depot,

Lahore, Pakistan.

ENG-101	English Composition and Comprehension	3(3-0)

Contents

Composition: Adverb and Adjectives; their forms and use; Articles and their use, prepositions ; Relative pronouns, clauses; Conditional sentences; Correction of sentences.

Comprehension: Getting the essential information; Effective communication; Comprehension writing, rules, practice; Order of importance: Application for job; Technical Report writing; Essay writing; Critical Reading and Thinking: The Damned Human Race (Article); How to live to be 200 (Article)

Suggested Readings

1. Advance Publishers. 2010. Advance Essays for All, Advance Publishers, Muslim Centre, Urdu Bazar, Lahore.
2. Ahmad, A. 2009. To The Point (English Grammar & composition for degree), To the point publishers, Yousaf Market, Ghazni Street, Urdu Bazar, Lahore.
3. Atta–Ur-Rehman, S. 2010. Effective Business Communication and Report Writing. Farrukh & Brothers, P.O Box 9025, Lahore Pakistan.
4. Khan, N. and G.S. Qureshi. 2011. A Selection of English Prose. The Carvan Book House, Katchery Road, Lahore.
5. Khan, Z.R. 2009. Simple Grammar and Composition (B.Sc English), Simple Publishers, 14 - Iqra Centre, Urdu Bazar, Lahore.

RS-401	Sociology for Engineers	2(2-0)

Contents

Studying the Group Dynamics; Types of Social Groups, Primary and Secondary groups, In-groups and Out-groups, Reference Group; Group Dynamics; Group Size, Leadership, Social Loafing, Social Dilemmas, Groupthink, Conformity. Types of Disputes: Dispute Resolution Techniques; Participatory Irrigation Management; Organizational Techniques for Sustainable Social Organizations: A Case Study; Community Development: A Case Study of AKRSP.

Suggested Readings

1. Bhatti, M.A., M.A. Cheema and G.V. Skogerboe. 1999. Maintenance and Operational Activities in the Command Area

of Shahpur and Mirwal Small Dam. Pakistan National Program International Irrigation Management Institute Lahore, Pakistan.
2. James, W. and V. Zanden. 1989. The Social Experience: An Introduction to Sociology. Random House. New York, USA.
3. Starkloff, R., D.J. Bandaragoda, M.A. Cheema, and M.A. Bhatti. 1999. Social Organization for Improved System Management and Sustainable Irrigation Agriculture in Mirwal and Shahpur Small Dams. Pakistan National Program International Irrigation Management Lahore, Pakistan.
4. Fledderman, C.D. 2011. Engineering Ethics. 4th Ed. Prentice Hall. New Mexico, USA.

AEE-302	Communication & Presentation Skills	3(2-1)

Contents

Definition, types and functions of communication; effective communication and its barriers; verbal communication skills; speaking, speech making, listening, reading and writing. Preparing and delivering a speech, development of effective reading skills, art of effective writing, writing scientific and popular articles. Listening: the process, types, barriers and strategies for effective listening; non-verbal communications; characteristics, functions and types; leadership; concept, techniques, functions and characteristics; development of effective leadership skills.

Practical:

Communication & Presentation Skills labs related to speaking, speech making, listening, reading and writing.

Suggested Readings

1. Calvert, P. 2000. The communication's Hand Book: Techniques and Technology.4th Ed. Maupin House, USA.
2. Devito, J.A. 2014. Human Communication: The Basic Course. 13th Ed. Pearson USA.
3. Gronbeck, B.E., R.E. McKerrow, D. Ehninger, and A.H.Monroe. 1999. Principles and Types of Speech Communication. 14th Ed. Harper Collins College Publishers. New York USA.
4. Kossen, S. 1994. The Human Side of Organizations. Harper Collins College Publishers. New York, USA.
5. Roy, E. and S. Roy. 1993. Guide to Basic Writing. Prentice Hall. Englewood Cliffs. New York, USA.

STAT-402	Statistics and Probability	3(2-1)

Contents

Statistics: Mean value, Measures of central tendency, Measures of variation, Standard deviation, Expected value of a random variable, Standard deviation of a random variable, The Poisson distribution, The uniform distribution, The exponential distribution, The normal distribution, The standard normal, The standard normal distribution. Probability: Sets, Application of Venn Diagrams, Introducing probability, Mutually exclusive events, The addition law of probability, Complementary events, Concepts from communication theory, Problems related to engineering, Conditional probability, The multiplication law, Independent events, Baye's formula, Permutations and combinations, Multiplication principle, Problems related to engineering, science and management, Applications of counting, Bernoulli trials, Binomial probability, Markov chains, Probability distribution, Expected value, Decision making, Problems related to engineering and management.

Practical

1. Simple, Multiple and Component bar diagram.
2. Historigram, Frequency polygon,
3. Frequency curve, c.f. curve, cumulative percentage curve and locate Quantiles.
4. Problem assignments relating probability.
5. Fitting a Binomial distribution.
6. Fitting a Poison distribution.
7. Fitting a Normal distribution.
8. Sampling distribution of difference between two means.
9. Application/use of t-test for Null hypothesis.
10. Test of significance of association of attributes by x^2-test (chi-square test).
11. Testing goodness of fit.
12. Calculating a simple, partial and a multiple correlation and their tests of significance. Fitting a simple linear regression equation and its test of significance by Analysis of Variance (F-test) and t-test.
13. Analysis of variance of data from C.R.D., R.C.B.D. and L.S. design.

Suggested Readings

1. Choudhry, S.M. and S. Kamal. 1998. Introduction to Statistical Theory Part I & II; Ilmi Kitab Khana, Kabir Street, Urdu Bazar, Lahore, Pakistan.
2. Kreyszig,E. Advanced Engineering Mathematics. 8th Ed. John

Wiley & Sons Publication.
3. Lind, D., W. Marchal, and S. Wathen. 2011. Basic Statistics for Business and Economics with Formula Card. 7th Ed. The Mcgraw-Hill/Irwin Series Operations and Decision Sciences, McGraw Hill Company. India.
4. Miller, I. and J.E. Freund. 1985. Probability and Statistics for Engineers. Prentice Hall, Inc., Englewood Cliffs. New Jersey, USA.
5. Muhammad, F. 1999. Statistical Methods and data analysis; Kitab Markaz, Bhowana Bazar, Faisalabad, Pakistan.
6. Walpole, R.E. 1982. Introduction to Statistics. 3rd Ed. McMillan publishing Co., Inc. New York, USA.
7. Taylor, L.D. 1974. Probability and Mathematical Statistics. Harper & Row, Publishers. New York, USA.
8. Walpole, R.E. 1982. Introduction to Statistics. 3rd Ed. McMillan publishing Co, Inc. New York, USA.

BBA-602	Operations Management	2(2-0)

Objective

This course is designed to provide the student with an understanding of the foundations of the operations function in both manufacturing and services. The Course will analyze operations from both the strategic and operational perspectives and highlight the competitive advantages that operations can provide for the organization. The goal of the course is to help students become effective managers in today's competitive, global environment. The course will examine operations as a competitive weapon, demand forecasting, supply-chain management, aggregate planning, inventory systems, just in-time systems and material requirements planning.

Contents

Introduction to operations management, competitiveness, strategy and productivity, Operations management models, Forecasting, Decision making, Transportation models, Waiting lines models, Learning curves, System Design, Product and service design, Strategic capacity planning for products and services: Decision theory process, Selection and facility layout: Linear programming, Design of work systems: Learning curves, location planning and Analysis: The management, Quality Control, Sampling Inventory Management and Scheduling, Inventory Management, Aggregate Planning, MRP, ERP, JIT and Learn Operations: Maintenance, Scheduling, Supply Chain Management, Supply Chain Strategies, Vendor selection, Internet purchasing, Supplier quality, Benchmarking, Types of facilities and location analysis

techniques. Transportation and distribution system, Project management, Waiting lines and simulations, Layout strategy, Basics layouts, Designing process layouts, Designing product layouts, Warehousing and storage layouts, Assembly line balancing, Hybrid Layouts.

Suggested Readings

1. William, J. S. 2012. Operations Management. 8th Ed. McGraw Hill, UK.
2. Heizer, J. and B.B. Render. 2012. Operations Management, 11th Ed. Prentice Hall, UA.
3. Roberta, S.R. and Taylor, W.B. 2012. Operations Management: Creating Value Along the Supply Chain, 4th Ed. McGraw Hill, UK.

ESE-	Electrical Engineering-II	3(3-0)

Basic concept of both the supply and utilization of electrical energy with some emphasis, contemporary aspects of energy utilization including modern developments, energy efficiency and environmental aspects. Electrical supply systems, transmission and distribution systems, reactive power effects, fault current calculation and protection. Utilization of electrical energy, industrial application consideration, including DC machines, induction and synchronous motor drives. Utilization of electrical energy for lighting and industrial heating processes including discharge, induction and RF heating, electrical safety of power equipments, requirements for use in hazards atmosphere earthing and earth leakage protection.

Practical

Practical related to the topic covered in theoretical part of the course.

Recommended Books

1. Theraja, B.L., A.K. Theraja. And M.K. Khedkar. 2014. A text book of Electrical Technology, Vol-III. S Chand & Co LTd.
2. Hughes, E., D.J. Hiley. And D.K. Brown. 2012. HUGES Electrical and Electronic Technology. 11th Ed. Pearson Hall.
3. Harlow, J.H. 2012. Electrical Power Trans former Engineering, 3rd Ed. CRC Press.

MICRO-501	Microbial Bioenergy and Biofuel	3(2-1)

Learning Objectives

After completing the course the students will be able to:

i. Familiarize with different types of microbes associated with bioenergy.
ii. Understand role of microbes in producing Bioenergy and Biofuel.
iii. Lab. scale production of bioenergy and biofuel using conventional digester.

Contents

Types of biomass (e.g. wood waste, forestry residues, agricultural residues, organic municipal solid waste). Types of microbial fuels (Biodiesel, Bioethanol, Biomethane/Biogas, Biohydrogen etc,), Phenomena for production of Biofuel (bioenergy and biofuel etc.), role of microbes (aerobic and anaerobic) in biofuel production and isolation and characterization of different aerobic and anaerobic. Isolation and characterization of biofuel producing bacteria (Biodiesel; E. coli, Microalgae, Biomethane; Methanogenic archae (Biohydrogen, Cyanobacteria, Clostridia, Bioalgae, Botryococcus bruanici, PNS Bacteria. Bioethanol (Lactobacillus casei, saccharomyces cerevisiae, Zymomonas morbilis, klebsiella oxytoca, E.coli, Clostridium cellulyticum, Preparation and studies of Consortium of microbes useful in Bioenergy/Biofuel. Microbial fuel cell.

Practical

Standard operating Lab procedures (safety measures and microbiology lab), sterilization protocol for lab equipment and glassware's. Equipment's used in isolation and characterization of biofuel producing bacteria, Different aerobic and anaerobic. Techniques helpful in isolating anaerobic biofuel forming Bacteria, Growth media, characterization with the help of morphology, biochemical tests, fluorescence test and other serological and molecular test, demonstration of laboratory scale conventional digester used in biofuel production. Visit to biofuel plant.

Recommended Books

1. Packiasamy, R. 2013. Seasonal Distribution of Methanogens in Manimuthar River. LAP LAMBERT Academic Publishing,
2. Bhojvaid, P.P. 2006. Biofuels: Towards a Greener and Secure Energy Future. The Energy and Resources Institute, India.
3. Arora, R. 2013. Microbial Biotechnology: Energy and Environment. 1st Ed. CABI India.
4. Khanal, S. 2011. Anaerobic Biotechnology for Bioenergy

Production: Principles and Applications. 1st Ed. Wiley-Blackwell.
5. Hallenbeck, P.C. 2012. Microbial Technologies in Advanced Biofuels Production. 2012 Ed. Springer USA.

CHEM-405	Photoactive Materials and Their Characterization	2(2-0)

Learning Objectives

To train students about the use of different materials for the fabrication of photoactive materials in Nano scale which possess maximum ability to harvest the sun light in visible region. Furthermore the working and principles as well as the characterization of solar cells. In the practical domain the use of potentiostat and cyclic voltametry is prime importance.

Contents

Introduction to Solid State Physics and Chemistry, Fabrication of nanostructure materials using semiconductor oxides, sulphides etc. Principles for measuring the band gap of semiconductors materials. Strategies to manufacture different morphologies of photoactive materials. Characterization of photoactive materials using spectroscopy, microscopy (SEM, TEM) and X-ray diffraction. Measurement of current voltage characteristics of the solar cells. Basics of Crystallography. Basic principles of electrochemistry, Role of electrolytes in the formation of the photovoltaic cells. Types of electrolytes and their limitations. Photo electrochemical cell. Electrodes and their selection. Dark current and light current. Concept of recombination of charges. Forward and reverse biasing.

Practical

Photometric measurement, preparation of their films of photoactive materials, measurement of conductance, surface area demonstration, light intensity measurement.

Suggested Readings

1. Wong, J. 2006. Analytical electrochemistry. 3rd Ed. John Willey & Sons, USA.
2. Christopher, M.A.B. and A. M. Brett. 1993. Electrochemistry Principles, Methods, and Application. 1st Ed. Oxford University Press.
3. McHardy, J. and F. Ludwig. 1993. Electrochemistry of Semiconductor and Electronics. 1st Ed. William Andrew Publications, USA.
4. Nelson, J. 2003. The Physics of Solar Cells. 1st Ed. Imperial College Press, UK.

5. Kurla, S.P. 2013. Essentials of solid state physics. New Central Book Agency (P) Ltd. London, UK.

FMP-504	Professional Ethics	2(2-0)

Learning Objectives

The objective of the course is to improve the ethical standards of students in engineering.

Contents

Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas. Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional ideals and virtues – Theories about right action – Self-interest – Customs and religion – Use of Ethical Theories.

Engineering as experimentation – Engineers as responsible experimenters – Codes of Ethics – A Balanced Outlook on Law – The Challenger Case Study. Safety and risk – Assessment of safety and risk – Risk Benefit Analysis – Reducing risk – The Three Mile Island and Chernobyl Case Studies

Collegiality and loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Discrimination.

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample code of conduct.

Suggested Readings

1. Martin, M. and R. Schinzinger, Ethics in Engineering. 2004. 4th Ed. McGraw Hill. New York, USA
2. Fledderman, C.D. 1999. Engineering Ethics. Prentice Hall New Mexico, USA.
3. Schlesinger, L. 1996. How Could You Do That: The Abdication of Character, Courage, and Conscience. Harper Collins, New York, USA.
4. Carter, S. 1996. Integrity, Basic Books, New York USA.

	Energy and Management	2(2-0)

Contents

Energy and its forms , energy resources, types, uses, merits and demerits of developing and using energy resources in Pakistan, Non-renewable and renewable patterns of energy consumption in Pakistan,

future energy scenario of World and Pakistan, sustainable energy management in Agriculture, transport industry and domestic sectors.
Impact of energy systems on environment and human health, impact of modern agriculture transport and industrial development on environment.
Carbon Credit Policy

Suggested Readings

1. Botkin, D.B. and Keller. 2007. Environmental Science: Earth as a Living Planet. 6th Ed. John Wiley and Sons.
2. Mckilley, M.L., R.M. Schoch. and Yonavjak. 2007. Environmental Science: Systems and Solutions, 4th Ed. Jones and Bartlett Publishers.

SCHEME OF STUDIES
FOR MS/ME ENERGY SYSTEMS ENGINEERING

Sr. #	Course Title	Credit Hours
1.	Energy Audit and Management	3(2-1)
2.	Solar Thermal Engineering	3(2-1)
3.	Bio Energy Engineering	3(2-1)
4.	Environmental Impact Assessment	3(3-0)
5.	Hybrid Power Sources	3(2-1)
6.	Hydro Power Plants	3(2-1)
7.	Wind Energy Engineering	3(2-1)
8.	Instrumentation in Energy Systems	3(2-1)
9.	Refrigeration And air Conditioning	3(2-1)
10.	Fuels And Combustion	3(2-1)
11.	Power Electronics and Motor Drives	3(2-1)
12.	Electrical Power Transmission and Distribution	3(2-1)
13.	Fluid Flow and Heat Transfer	3(2-1)
14.	Renewable Energy Systems	3(2-1)
15.	Energy Systems Modelling and Simulation	3(2-1)
16.	Advanced Clean Coal Technologies	3(3-0)
17.	Combustion and Pollution Control	3(2-1)
18.	Hydrogen Technologies and Fuel Cells	3(2-1)
19.	Energy Management in Buildings	3(2-1)
20.	Energy Economics and Management	3(3-0)
21.	Solar Photovoltaic Systems	3(2-1)
22.	Biofuels Engineering	3(2-1)
23.	Nuclear Power Plant Engineering	3(3-0)

ESE-	ENERGY AUDIT AND MANAGEMENT	3(2-1)

Learning Objectives

To train the students about energy management, monitoring and auditing.

Contents

Energy Overview – Energy Management Techniques, Role of Energy Managers in Industries- Energy monitoring, auditing & targeting – Economics of various Energy Conservation schemes. Total Energy Systems Energy Audit -various Energy Conservation Measures in Steam -Losses in Boiler. Energy Conservation in Steam Systems -Case studies. Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressors– energy consumption and energy saving potentials – Design consideration.

Refrigeration & Air conditioning - Heat load estimation -Energy conservation in cooling towers & spray ponds – Case studies Electrical Energy -Energy Efficiency in Lighting – Case studies. Organizational background desired for energy management motivation, detailed process of M&T-Thermostats, Boiler controls- proportional, differential and integral control, optimizers; compensators.

Practical

The practical work will be based on Theory Work.

Suggested Readings

1. Eastop, T.D and D.R. Croft. 1990. Energy Efficiency for Engineers and Technologists. Logman Scientific & Technical. Pearson Education.
2. Reay, D.A. 1977. Industrial Energy Conservation: A hand book for engineers and managers, 2nd Ed. Pergamon Press, UK.
3. Larry, C.W., P.S. Schmidt. And D.R. Brown. 1988. Industrial Energy Management & Utilization, 1st Ed. Springer Publishers, New York. USA.
4. Kothari, D.P. and I.J. Nagrath. 2008. Power System Engineering, 2nd Ed. Tata McGraw Hill, India.

ESE-	SOLAR THERMAL ENGINEERING	3(2-1)

Learning Objectives:

To impart the sound knowledge of solar thermal system design in order to utilize the solar energy for the communities.

Contents

Solar resource assessment, extraterrestrial radiation on horizontal surfaces, available solar radiation and total radiation on slopped surfaces; solar charts, pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder. Heat transfer in solar systems: natural convection between parallel flat-plates, heat transfer relations for internal flow; radiation characteristics of opaque materials; radiation transmission through covers and absorption by collector; transmittance-absorptance product, monthly average absorbed solar radiation; theory of flat-plate collectors: collector overall heat loss coefficient, collector heat removal factor and flow factor, mean fluid and plate temperature, heat capacity effects on flat-plate collectors; flat-plate collector performance: incidence angle modifier, thermal test data conversion; design of solar heating systems, passive solar energy systems. Case studies related to active and passive use of solar energy.

Design of concentrated collectors, and performance analysis, classification - concentrator mounting –Focusing solar concentrators-parabolic trough concentrators, paraboloidal concentrators, Scheffler fixed focus concentrators, Heliostats. Automatic tracking systems, energy storage, distillation still and solar cookers. Solar-based Sterling Engine, solar process economics; cost of solar process systems, life cycle savings methods.

Practical

The practical work will be based on Theory Work.

Suggested Readings

1. Duffie, J. A. and W.A. Beckman. 2013. Solar engineering of thermal processes, 4th Ed. John Wiley and Sons, New York USA.
2. Kaltschmitt, M., W. Streicher. and W. Andreas. 2007. Renewable Energy: Technology, Economics and Environment, 1st Ed. Springer Publishers, New York. USA.
3. Goswami, D.Y., F. Kreith. and J.F. Kreider. 2000. Principles of Solar Engineering, 2nd Ed. Taylor & Francis, India.
4. Anderson, E.E. 1983. Fundamentals for solar energy

conversion. Addison Wesley Publ. Co.
5. Duffie, J. A. and W.A. Beckman. 2006. Solar engineering of thermal processes, 4th Ed. John Wiley and Sons, New York USA.

ESE-	BIO ENERGY ENGINEERING	3(2-1)

Learning Objectives

To acquaint the students with the knowledge of biomass resources, combustion, and their power generation potential.

Contents

Sources and Classification. Chemical composition, properties of biomass. Energy plantations, Size reduction, Briquetting, Drying, Storage and Supply chain management of biomass, Energy reclamation from agricultural crops/wastes, Different sources of biomass for energy production, Different components and efficiency calculation of biomass fired boilers, Thermo chemical conversion of lignocelluloses biomass. Incineration, Processing for liquid fuel production. Pyrolysis -Effect of particle size, temperature, and products obtained. Thermo chemical Principles: Effect of pressure, temperature, steam and oxygen. Fixed and fluidized bed Gasifiers- Partial gasification of biomass by CFB, types, design, development and evaluation of gasifier for heat and power generation. Combustion of woody biomass-Design of equipment. Cogeneration using bagasse- Case studies: Combustion of rice husk.
Feedstock for biogas, Microbial and biochemical aspects- operating parameters for biogas production, Anaerobic digestion for methane production- basic processes, anaerobic fermentation, fermentation kinetics, digester design parameters, various types of biogas plants. Design, installation, operation and management of biogas plants, purification of biogas. Power generation from biogas plants, Concept of CHP in energy production, gas and digester effluent utilization strategies, design of efficient bio-digesters; Kinetics and mechanism- High rate digesters for industrial waste water treatment.

Practical

The practical work will be based on Theory Work.

Suggested Readings

1. Chakraverthy, A. 1989. Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes. Oxford & IBH publishing Co. New Delhi.
2. Goswami, D.Y., F. Kreith. and J.F. Kreider. 2000. Principles of Solar Engineering, 2nd Ed. Taylor & Francis, India.

3. Mital, K.M. 2007. Biogas Systems: Principles and Applications. New Age International publishers Pvt. Ltd. New Dehli India.
4. Nijaguna, B.T. 2006. Biogas Technology. Reprint Ed. New Age International publishers Pvt. Ltd. New Dehli India.
5. Rezaiyan, J. and N.P. Cheremisinoff. 2005. Gasification Technologies, A Primer for Engineers and Scientists, 1st Ed. Taylor & Fran cis Publishers.
6. Khandelwal, K.C. and S.S Mahdi. 1986. Tata McGraw-Hill Publishers. India.

ESE-	ENVIRONMENTAL IMPACT ASSESSMENT	3(3-0)

Learning Objectives

To understand the application of impact assessment techniques for various developmental activities.

Contents:

Principles, Production and assessment of impacts due to pollutants on the environment. Environment Impact Assessment in the land and biological environment Methodologies for Environmental Impact Assessment – Case studies Assessing Impacts and Setting Priorities – Economic Measurement of Environmental Impacts– Theoretical Basis and Practical Applications. Selectively Applicable Techniques of Valuing Environmental Impacts-Potentially Applicable Techniques of Valuing Environmental Impacts. The limits of Economic Measurement of Environmental Impacts –Case studies, EIA of Energy related projects.

Suggested Readings

1. Barthwal, R. R. 2010. Environmental Impact Assessment 2nd Ed. New Age International publishers Pvt. Ltd. New Dehli India.
2. Holling, C.S. 2005. Adaptive environmental assessment and Management. Black Burn press, New York USA.
3. Canter, L.W. 1995. Environmental Impact Assessment, 2nd Ed.McGraw Hill Book Company.

ESE-	HYBRID POWER SYSTEMS	3(2-1)

Learning Objectives

To impart the sound knowledge regarding innovative technologies related to hybrid power of automobiles.

Contents

History of Electric Vehicles, Electrochemical Power Sources, Electric Vehicle Debate, Primary Energy Sources and Alternative Fuels for Transportation– Secondary Batteries and Fuel Cells.

Sources- Aqueous Electrolyte Batteries –Lead Acid, Nickel – Iron, Nickel – Zinc, Metal –Air Zinc-Halogen Non Aqueous Electrolyte Batteries- High Temperature Batteries, Organo Electrolyte and Solid State Batteries. Overview of Performances of Candidate Secondary Battery Systems-Fuel Cells – Acid Systems, Direct Methanol / Air Systems, Alkaline Systems-Overview of Performances of candidate Fuel Cell Systems, SOFC- Emerging areas in Fuel cells Fuel cell outlook, Sources, comments, & revision history, Applications –Industrial and commercial, Battery/Fuel cell/ Internal Combustion Engine Hybrid Electric Vehicles, Laboratory Test of Electric Vehicle Batteries, Vehicle tests with Electric Vehicle Batteries, Future of Electric Vehicles, Emerging trends in batteries. Specifications - Storage cell definitions & specifications, Carbon-zinc & alkaline cells, Battery -Storage Cell Technologies-Storage cell fundamentals- Characteristics, solar based electric vehicles, design principles of electronic control of hybrid vehicles.

Practical

The practical work will be based on Theory Work.

Suggested Readings

1. McNicol, B.D. and D.A.J. Rand. 1998. Power Sources for Electric Vehicles. Elsevier Publications USA.
2. John, V. 1990. Lithium Batteries for Hybrid Cars. Spectrum Publishers.
3. David, L. and Thomas. 2002. Hand Book of Batteries and Fuel cells, 3rd Ed. McGraw Hill Book Company, NY.USA.
4. Viswanathan, B., M.Aullice. and Scibioh. 2008. Fuel Cells, Principles and Applications. CRC Press, USA.
5. Nick, Y. 2006. The Essential Hybrid Car Handbook: A Buyer's Guide, 1st Ed. The Lyons Press, NY. USA.

ESE-	HYDRO POWER PLANTS	3(2-1)

Learning Objectives

To develop in the students the capability to understand, design, develop and implement hydro-power plants.

Contents

General Introduction :- Hydropower potential, Concept of Modern Hydro Power Plant , Location /Site Selection, Plant Layout, Power Plant Safety Reservoir, Dams & Tunnels etc. Constructional details and basic principles of Hydro-mechanical equipment, Hydrology & Hydro - Electric Power Plants- Hydrographs – Flow duration curve – Mass curve & storage. Site selection for hydroelectric power plants. Design Construction & Operation of Hydro-Electric Power Plants- Components- Advantages & Disadvantage of under-ground power station Turbine and auxiliaries, Construction and working principles of various types of Valves and Pumps and Hydraulic System. Construction and working principles of Alternators and Excitation Systems, Transformers, Motors, Switchgears. Operation, Control and Supervision of Hydro Power Plant. Instrumentation & Control (including DAS & DDC) and Protection system. Erection, Commissioning and Testing Aspects of Hydro Power Plant.

Micro-hydro power: Introduction, Present situation, Future potential and prospects, Constraints, Flow measurement, working principles of different types of turbines, details of the components of a micro-hydel power system, turbine selection criteria, site selection and feasibility study.

Practical

The practical work will be based on Theory Work.

Suggested Readings

1. Black and Veatch. 1995. Power Plant Engineering, 1st Ed. Springer Publishers.
2. Rao, S. and B.B. Parulekar. 1995. Energy Technology, 3rd Ed. Khanna Publisherr, India.

ESE-	**WIND ENERGY ENGINEERING**	**3(2-1)**

Learning Objectives

The study of this course will enable the students to design different types of wind turbines for power generation.

Contents

General characteristics of wind resources, wind data analysis and resource estimation, wind turbine energy production estimation methods, Wind measurement and instrumentation, Principal Wind Turbine Components and their functions. Spacing of the Towers. Horizontal Axis Versus Vertical Axis wind turbines. One-dimensional Momentum Theory

and the Betz Limit. Wake Rotation in HAWT, Aerodynamic of Horizontal Axis Wind Turbine- Airfoil Aerodynamics, flow over an Airfoil, Airfoil Behavior, Airfoil Flow Regime, Airfoil for Lift and Drag Machines. Blade design, Momentum and Blade Element Theory, Stresses due to Blade Weight and centrifugal force, Blade Natural Frequencies. Blade Shape for Ideal Rotor. Rotor Design: Basic Rotor Parameters, Blade Shape, Rotor Performance. Aerodynamic Control Options, Power Curve Prediction. Aerodynamics of Vertical Axis Wind Turbines-Single Stream Tube Analysis, Multiple Stream Tube Momentum Theory, Aerodynamics of the Darrieus and Savonius Rotor, Environmental Aspects of Wind Turbines.

Practical

The practical work will be based on Theory Work.

Suggested Readings

1. Manwell, J.F., J.G. McGowan. And A.L. Rogers. 2009. Wind Energy Explained, Theory, design and application, 3rd Ed. John. Wiley and Sons, U.K.
2. Tong, W. 2010. Wind Power Generation and Wind Turbine Design, 1st Ed. WIT Press, USA.
3. Rao, S. and B.B. Parulekar. 2005. Energy Technology, 4th Ed. Khanna Publishers. India
4. Patel, M.R. 2014. Wind and Solar Power Systems, 2nd Ed. Taylor & Francis.
5. Freris, L. 1990. Wind Energy Conversion Systems. Prentice Hall.
6. Spera, D.A. 2013. Wind Turbine Technology: Fundamental concepts of Wind Turbine, Engineering, 2nd Ed. ASME Press, USA.

ESE-	INSTRUMENTATION IN ENERGY SYSTEMS	3(2-1)

Learning Objectives

This course will give acquaintance to the students about the use of instruments, data-logging for the performance evaluation of different energy systems.

Contents

Measurement Errors - Materials, radiant storage- Transducer classification- Static and dynamic characteristics of transducers, Transient analysis of a control system. Temperature Measurement - Bimaterials, Pressure thermometers, Thermocouples, RTD, Thermisters, and Pyrometry, pyrometers- Calibration of Pressure measuring equipment. Flow Measurement- Variable head flow meters- Rota meters,

Electromagnetic flow meters, Hot wire anemometers, Hot film transducers, Ultrasonic flow meters. Air pollution and Miscellaneous Measurements- Particulate sampling techniques, SO_2, Combustion Products, Opacity , odour measurements - Measurement of liquid level, Humidity, O_2, CO_2 in flue gases- pH measurement Moving Iron/coil, Energy measurement, power factor meter-Analog signal conditioning, Amplifiers, Instrumentation amplifier, A/D and D/A converters, Digital data processing and Data acquisition system.

Practical:

The practical work will be based on Theory Work.

Suggested Readings

1. Sawhney, A.K. and P. Sawney. 2002. A course in Mechanical Measurements and Instrumentation, 1st Ed. Dhanpat Rai & company, India.
2. Bechwith., Marangoni. And Lienhard. 2000. Mechanical Measurements, 5th Ed. Addison Wesley, USA.
3. Holman, J.P. 1994. Experimental methods for engineers, 6th Ed. McGraw-Hill Company.

ESE-	REFRIGERATION AND AIR CONDITIONING	3(2-1)

Learning Objectives

To train the students about emerging technologies of refrigeration and air conditioning using conventional and solar thermal technologies

Contents:

Thermodynamic concepts, refrigeration cycles, air and vapor compression, characteristics of refrigerants, refrigeration systems, principles of operation and types of compressors, expansion devices, evaporators, condensers, Heat load estimation, psychometric analysis; design principle of cold storage, principles of air conditioning, methods of refrigeration. Determination of sensible and latent heat factor, , absorption and adsorption cycles, solid and liquid desiccant evaporative cooling systems, ejector cooling cycle, evaporative air cooling, Air-cycle steam jet. Refrigeration systems and their performances:, absorbers, cooling towers, fan coils, air-duct system, etc. Comfort factors-specifications –Limits for humidity, temperature etc., air distribution, ventilation, instrumentation. Alternate solar cooling systems

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Stoecker, W.F. 1980. Refrigeration and Air Conditioning. TMH Ed. McGraw Hill publication.
2. Ballaney, P.L. 1980. Refrigeration and Air Conditioning. Khanna Publishers. India.
3. Trott, A.R. 1980. Refrigeration and Air Conditioning, 2nd Ed. Butterworth Publishers, UK.

ESE-	FUELS AND COMBUSTION	3(2-1)

Learning Objectives: To establish a link between principles and practical applications in the field of Fuels and Combustion Technology.
Contents:

Fuels and their classification. Petroleum-based Fuels And Related Environmental Issues. Alternative Fuels and their properties: Light (Gaseous) Hydrocarbons, propane-butane gas, Mixtures of Synthetic Liquid Hydrocarbons, alcohols, ethers, vegetable Oils and their Oxygen-Containing derivatives. Fuel additives and their use. Blending of fuels.

Fuel related Thermodynamic Fundamentals, Combustion Stoichiometry and Thermo chemical Calculations–Air fuel ratio. Combustion Thermodynamics- calculation of heat of formation & heat of combustion – First law analysis of reacting systems, Heat Treatment Furnaces- Industrial furnaces – process furnaces – Kilns – Batch & continuous furnaces Flame, Flame Structure, Ignition and Igniters – flame propagation – deflagration – detonations- flame front – Ignition – self & forced ignition – Ignition temperature Combustion Appliances- Gas burners- Functional requirement of burners – Gas burner Classification – Stoker firing –pulverized system of firing.
Turbulent Premixed and Diffusion Flames, Characteristics of Turbulent Confined Diffusion Flames. Emission in Boilers and Furnaces.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Sharma, S.P. and C. Mohan. 1984. Fuels & Combustion. McGraw Hill Publishing Company.
2. Sarkar, S. 1990. Fuels & Combustion, 2nd Ed. Orient Longman, National Institute of Technology, Tiruchirappalli. India.
3. Blokh, A.G. 2000. Heat Transmission in Steam Boiler furnaces. Hemisphere Publishing Company.

4. Gupta, O.P. 1996. Elements of Fuels, Furnaces & Refractories, 3rd Ed. Khanna Publishers, India.
5. Strehlow, R.A. 2000. Combustion Fundamentals. McGraw-Hill Publishing Company.
6. Shaha, A.K. 2002. Combustion Engineering and Fuel Technology. Oxford and IBH Publishers.
7. Kou, K.K. 2005. Principles of Combustion, 2nd Ed. John Wiley & Sons.
8. El-Mahallawy, F. 2002. Fundamentals and technology combustion, Kindle Ed. Elsevier Science Ltd, USA.
9. Srivastava, S. P. and J. Hancsók. 2014. Fuels and Fuel additives, 1st Ed. John Wiley & Sons

ESE-	POWER ELECTRONICS AND MOTOR DRIVES	3(2-1)

Learning Objectives:

To train the students in the field the power electronics that will enable them to convert energy into different forms.

Contents:

Solid- State Devices, Latest development in the area of Power Electronics covering modern devices, converter topologies & control strategies.

Power Electronic Converters, Pulse width modulated rectifiers, Controlled rectifiers, single phase and three phase inverters, AC voltage controllers, DC-DC Converters, switch mode converters, Cyclo-converters, Matrix converters, Resonant and Soft-Switching Converters, High Frequency switching converters, State-space averaged modeling of power electronic converters. Power Factor analysis and instrumentation of power electronic converters, Brief description of some special applications of power electronic converters, Control Methods for Power Electronic Converters Sliding-Mode control of Power Converters, Fuzzy Logic and Neural Netrwork Control of Power Converters. Solid State Drives, Motors operation on non-sinosoidal supply, Closed loop control of solid state drives, Inverter fed induction motor drives, Cyclo-converter controlled AC drives, Chopper fed speed control of dc motor drives, Speed control of Switched-reluctance motors, brushless dc motors, stepper motors using power electronic converters, Brushless excitation of synchronous machines. Application of microprocessor, microcontroller, PLC in solid state drives.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Rashid, M.H. 2011. Power Electronics Hand Book. McGrey Hill Company Ltd.
2. Erickson, R.W. 2012. Fundamentals of Power Electronics, 2nd Ed. McGraw Hill Company.
3. Bimal, K.B. 2010. Power Electronics and Motor Drives:Advances and Trends, Kindle Ed. Academic Press

ESE-	**ELECTRICAL POWER TRANSMISSION AND DISTRIBUTION**	**3(2-1)**

Learning Objectives:

To enable the students to transmit electric power to the load center.

Contents:

Transmission system planning, Complex power in balanced three phase transmission lines. Power flow in transmission lines.
Performance Analysis of Transmission system - Transmission line constants, bundled conductors, Parallel lines, Steady state power limit and voltage regulation in Short transmission lines. Medium transmission line, A, B, C & D constants. Nominal π and nominal T circuits. Analysis of Long transmission lines, Line and load compensation, series and shunt compensation. Environmental effects of overhead lines.

Underground Cables - Types of underground cables, Cable installation techniques, Electric stress, dielectric constant, charging current, insulation resistance, skin effect and proximity effect, current carrying capacity of cables.

Distribution System Planning - Importance of distribution system planning, load forecasting. Factors affecting distribution system planning, planning methods, computer applications, distribution automation and control, Distribution system in Pakistan, Planning constraints in Pakistan
Distribution Substation - Distribution substation, Substation bus schemes. Rating of Distribution substation, limitation of service area. Square and hexagonal service area. Distribution transformer, distribution transformer efficiency, parallel operation of transformers, vector groups

Design Considerations for Primary and Secondary Distribution Systems - Primary distribution feeders, Primary feeder voltage level and loading, Design considerations for Radial feeders, Economic design of secondary lines, voltage fluctuation. Voltage regulation, Distribution system voltage control, line drop compensator.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Gonen, T. 2014. Electrical Power transmission System Engineering, 3rd Ed. CRC Press, USA.
2. Grainger, J.J. and W.D. Stevenson. 2010. Power System analysis. McGraw-Hill Scieence/ Engineering/Math.
3. Stevenson, W.D. 1982. Elements of Power System, 4th Ed. McGraw Hill Higher Education.

	FLUID FLOW AND HEAT TRANSFER	**3(2-1)**

Learning Objectives:

After studying the course, student should have understanding of advanced heat and fluid flow processes and their role in modern methods of power generation; in-depth understanding of numerical and experimental techniques in heat and fluid flow

Contents:

Fluid Mechanics - Fluid properties, Fluid classification, Kinematics and Dynamics of fluid, fundamental techniques of computational fluid dynamics, Navier-Stokes equations for viscous flow, Mass, momentum and energy conservation equations, Boundary layer and Potential flow, Laminar and turbulent Boundary layers, NS equation applied to Boundary layer and potential flow, Numerical solutions and convergence criteria, Grid generation, discretization methods, turbulence modeling.
Heat Transfer - Specific heat, work and heat transfer, Heat conduction, heat exchangers, steady and unsteady heat conduction, convection, convection heat transfer co-efficient, free and forced convection, radiation properties (Absorptance, Transmittance and Reflectance), black body radiation, shape factor and view factors, solar radiation.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Versteeg, H.K. and W. Malalasekera. 2007. An Introduction to Computational Fluid Dynamics, 2nd Ed. Prentice Hall.
2. Graebel, W.P. 2007. Advanced Fluid Mechanics, Academic Press.
3. Patanker, S.V. 1980. Numerical Heat Transfer and Fluid Flow, CRC Press.

4. Cengel, Y. and A.J. Ghajar. 2010. Heat and Mass Transfer, 4th Ed. McGraw Hill Publishing Company.

ESE-	RENEWABLE ENERGY SYSTEMS	3(2-1)

Learning Objectives:

On completion of this course, students would be able to understand, design and simulate various renewable energy systems such as small hydropower, wind power, solar energy, biomass energy etc in the global as well as national perspective.

Contents:

Energy scenario of Pakistan and the world; Energy crisis, Environmental hazards; Opportunities for renewable energy utilization.

Solar energy resource; Solar thermal collectors and applications; Solar photovoltaic cells and modules; Solar PV system applications; Wind characteristics and resources; Fundamental principles, basic parts and aerodynamics of wind turbines/ plants; Applications of wind power. Small Hydropower; Components and applications.

Biomass energy resources; Waste to energy; Biomass energy conversion systems; Biomass energy applications; Ocean Energy; Tidal characteristics and resource, Tidal power generation; Wave energy resource and conversion; Ocean thermal energy conversion. Geothermal energy; Geothermal resources and power generation, Hybrid energy systems.

Design and sizing of renewable energy systems, Renewable energy storage and transmission; Integration of renewable energy systems; Economic analysis; Social and environmental aspects; Simulation of renewable energy systems; Renewable energy legislation and regulations; Future of renewable energy.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Twidell, J. and T. Weir. 2000. Renewable Energy Resources, 2nd Ed. Taylor and Francis, USA.
2. Quashing, V. 2000. Renewable Energy Conversion, Transmission, and Storage. Earthscan, Bent Sorensen Academic Press, USA.
3. Uqaili, M.A. and K. Harijan. 2012. Energy, Environment and

Sustainable Development. Springer-Verlag.

ESE-	ENERGY SYSTEMS MODELLING AND SIMULATION	3(2-1)

Learning Objectives:
To impart knowledge regarding mathematical modeling and simulation of Energy System.

Contents:
Introduction to energy systems modeling and simulation; Importance of modeling and simulation in energy systems; Modeling overview - steps in model development; Nature of Energy Systems Models and Analysis- Response of Energy Systems and their Analysis; Quantitative techniques: Interpolation - polynomial, Lagrangian; Curve fitting; Regression analysis; Solution of transcendental equations; Systems simulation - information flow diagram, Optimization: objectives/constraints, problem formulation; Linear programming - simplex tableau, pivoting, sensitivity analysis, Dynamic programming, Search techniques- univariate/multivariate; Dealing with uncertainty - probabilistic techniques; Pinch analysis; Energy-Economy Models: Scenario generation, Input-Output Models, Numerical solution of differential equations; Transit analysis; Analytics of System Data- Modeling of electrical machines/loads- Modeling of the grid synchronization and modulation techniques- Smart Grid modeling. Energy Modeling Tools.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Severance, F.L. 2001. System Modeling and Simulation-An Introduction, 1st Ed.
   John Wiley and Sons.
2. Cha, P.D., J.J. Rosenberg. and C.L. Dym. 2000. Fundamentals of Modeling and Analyzing Engineering Systems, 1st Ed.
   Cambridge University Press, UK.
3. Law, A.M. and W.D. Kelton. 2014. Simulation Modeling and Analysis, 5th Ed. McGraw-Hill Education.
4. Ferrarini, L and C. Veber. 2009. Modeling, Control, Simulation and Diagnosis of Complex Industrial and Energy Systems. International Society of Automation, USA.

ESE-	ADVANCED CLEAN COAL TECHNOLOGIES	3(2-1)

Learning Objectives:
To impart knowledge regarding Coal as an important source for Energy and its utilization for energy conversion system.

Contents:
Introduction to clean coal technologies, Coal reserves and its uses. Direct and indirect coal liquefaction-process description, parameters, catalyst preparation, characterization, Hydrocracking/ Hydrotreating reaction mechanism and kinetics, Single stage and two stage liquefaction, catalytic reactors system. FT reactor overview, Reaction mechanism, kinetics Syn gas production and composition, syn gas purification, and process parameters, Energy analysis/ Heat exchanger network optimization in FT synthesis, Products refinery Products analysis, and health safety and Environmental considerations. Hybrid approach to synthesize liquid fuels, Comparison of ICL and DCL, Hybrid approach description/ Process flow diagrams. Clean coal gasification - process description, coal preparation, gasifier design, reaction kinetics, gas cleaning. Integrated Gasification Combine cycle (IGCC) - process description, thermodynamic cycle, CO_2 pre combustion capture and storage, Energy requirements.
Underground coal gasification (UCG) - overview, important geological aspects for design consideration, Channel formation b/w injection and production wells, Process parameters/Coal and Rock properties, Economics consideration.
Carbon capture techniques, Power Generation technologies incorporating CO_2 Capture, CO_2 Capture Chemical Processes.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Miller, B.G. 2010. Clean Coal Engineering Technology. 1st Ed. Butterworth-Heinemann, Oxford.UK.
2. Spaite, P.W. 1986. Emerging clean coal technologies. Noyes Pubns.
3. Bell, D.A. and B.F. Towler. 2010. Coal Gasification and its Applications, 1st Ed. William Andrew, USA.

ESE-	COMBUSTION AND POLLUTION CONTROL	3(2-1)

Learning Objectives:
To provide an understanding of the fundamentals of combustion and the formation and control of pollution including current /International regulations relating to this.

Contents:

Fundamentals of combustion principles, Theoretical and actual combustion processes, Combustion chemistry, combustion thermodynamics, combustion stoichiometry, chemical equilibrium, flame types and properties, fossil fuel utilization and combustion mechanism, biomass combustion and co-firing, formation and control of combustion pollutants. Current National and international regulations related to air pollution and combustion generated pollutants. Global, regional and local environmental issues.

Design and sizing of environment pollution control technologies; Simulation of environmental systems; Environmental impact assessment of energy projects; Environmental management, Environmental health and safety; Legal and economic tools for energy/environmental policies including international agreements and programs as well as economic mechanism.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Turns, S.R. 2011. An Introduction to Combustion: Concepts and Applications, 3rd Ed. McGraw Hill Company.
2. Borman, G.L. and K.W. Ragland. 1998. Combustion Engineering, 1st Ed. McGraw Hill Company.
3. Salvateo, J.A., N.L. Nemerow, and F.J. Agarady. 2003. Environmental Engineering, 5th Ed. John Wiley & Sons.
4. Dara, S.S. 2004. Environmental Chemistry and pollution Control, 7th Ed. S Chand & Co Ltd, India.

ESE-	HYDROGEN TECHNOLOGIES AND FUEL CELLS	3(2-1)

Learning Objectives:
To impart knowledge to the students regarding the importance, production and utilization of hydrogen energy.

Contents:

Overview of the hydrogen economy; Hydrogen production technologies; Principles and operation of hydrogen production systems; Hydrogen production from fossil fuels, nuclear energy; renewable energy; Estimation of hydrogen energy potential; Economics of hydrogen; Hydrogen end-uses; Transportation, distribution and storage of hydrogen; Social and environmental aspects; Design and sizing of hydrogen systems; Simulation of hydrogen system performance; Future of hydrogen energy.

Principles and operation of various types of fuel cells; Configuration of individual cells, stack and fuel cell system; Thermodynamics of fuel cells; Introduction to electrochemical kinetics; Transport-related phenomena and conservation equations for reacting multi-component systems; Fuel cell system design, optimization and economics; Fuel cell performance simulation; Applications of fuel cells; Social and environmental aspects; Challenges of fuel cell commercialization; Future of fuel cells

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1) Sorenson, B. 2011. Hydrogen and Fuel Cells-Emerging Technologies and Applications, Kindle Ed. Elsevier Publishers Ltd, USA.
2) Stolten, D. and B. Emonts. 2012. Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications, 1st Ed. John Wiley & Sons.
3) Sperling, D. and J.S. Cannon. 2004. The Hydrogen Energy Transition-Moving Towards the Post Petroleum Age in Transportation, 1st Ed. Elsevier Academic Press, USA.

ESE-	ENERGY MANAGEMENT IN BUILDINGS	3(2-1)

Learning Objectives:

To enable students to gain essential practical understanding of energy systems in buildings

Contents:

Processes in Building; Indoor Activities and Environmental Control, Internal and External Factors on Energy Use and the Attributes of the Factors, Characteristics of Energy Use and Its Management, Macro Aspect of Energy Use in Dwellings and Its Implications

Indoor Environmental Requirement and Management; Thermal Comfort, Ventilation and Air Quality, Air-conditioning Requirement, Visual Perception, Illumination Requirement, Auditory Requirement Climate, Solar Radiation and Their Influences; The Sun-earth Relationship and the Energy Balance on the Earth's Surface, Climate, Wind, Solar Radiation, and Temperature, Sun Shading and Solar Radiation on Surfaces, Energy Impact on the Shape and Orientation of Buildings. End-use Energy Utilization and Requirements; Lighting and Daylighting, End-use Energy Requirements, Status of Energy use in Buildings, Estimation of Energy Use in a Building Heat Gain and Thermal Performance of Building Envelope
Steady and No steady Heat Transfer Through the Glazed Window and the Wall, Standards for Thermal Performance of Building Envelope, Evaluation of the Overall Thermal Transfer Non-Steady Heat and Moisture Gain through Building Envelope; Single and Multi-Dimensional Problems, Transfer Function and Finite-Difference Solution, Energy Balance Concept and its Implementation Technologies for Low Energy Buildings; Application of Radiant Barriers With other Building Materials, Solar-Generated Desiccant Dehumidification for Ventilation, Radiant Panel Cooling, Natural and Active Cooling with Adaptive Comfort, Daylighting Application. Heat Gain Through Window; Solar Radiation Transmission through Complex Fenestration System, Thermal Gain and Net Heat Gain, Methods of Control
Dynamic Air-Conditioning Load; Dynamic and Latent Heat Gain from External and Internal Source by Air, Cooling Coil Load and Air-Conditioning Load Energy Prediction; Prediction of Energy Use by Simple Indicators and by Building Energy Simulation, Application of Neural Network for Energy Prediction

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1) Krieder, J. and A. Rabl. 2009. Heating and Cooling of Buildings: Design for Efficiency, 2nd Ed. CRC Press, USA.
2) Guinnes, S.M. and Reynolds. 1982. Mechanical and Electrical Equipment for Buildings, 8th Ed. John Wiley and Sons.
3) Shaw, A. 1989. Energy Design for Architects. Fairmont Press.
4) Agrawal, B. and G.N. Tiwari. 2010. Building Integrated Photovoltaic Thermal Systems For Sustainable Developments. Royal Society of Chemistry, India

ESE-	ENERGY ECONOMICS AND MANAGEMENT	3(3-0)

Learning Objectives:

To provide implementable knowledge to the students regarding the energy economics, different energy management strategies and their benefits.

Contents:

Energy and Resource Economics - Economic theories and management of energy resources, Evaluation of external effects of energy use; Modeling energy and resource use; Using energy mix in devising sustainable development strategies and plans, econometric models. Energy Challenges, Pricing and Macro Economy-Concepts - Energy pricing, Measures to reduce energy import bill, Role of energy resources in economic development, analyze the impact on different economies.
Energy Tariffs, Taxation and Subsidies - Types of tariffs, current tariff system, Taxation and Subsidies, Need for comprehensive reforms for pricing system, Energy contracts, levelized cost of electricity, energy audits, asset management.

The Economics of Climate Change - Energy and Climate Change, Clean Development Mechanism Estimation of damage costs from climate change; evaluation of climate change mitigation options; problems of international cooperation on climate change policy; distributional implications of climate change and climate change policy. Energy Management - Project management, Demand side management; Electrical Systems load scheduling/shifting, Energy modeling and forecasting; Financing energy conservation programs.

Energy Markets and Policy - The function of the major markets for energy: oil, coal, natural gas, electricity, and alternative/renewable energy in a national and international context; Deregulation of Energy Markets , the technological structure and parameters of energy supply and use; forecasting supply or demand for energy;. Energy Independence and sovereignty, Energy Policies, Privatization, Energy sector regulation, OGRA, NEPRA etc.

Suggested Readings:

1. Chakrbati, A. 2011. Energy Engineering and Management, Kindle Ed. PHI publishers, India.
2. Turner, W.C. and S. Doty. 2012. Energy Management Handbook, 8th Ed. Fairmont Press.
3. Bhattacharyya, S.C. 2011. Energy Economics: Concepts, Issues, Markets and Governance. Springer Verlag.

4. Trivedi, P.R. and K.R. Jolka. Energy Management. Commonwealth Publication.
5. Witte, L.C., P.S. Schmidt, and D.R. Brown. 1988. Industrial Energy Management and Utilization, 1st Ed. Hemisphere Publ, Washington USA.

ESE-	SOLAR PHOTOVOLTAIC SYSTEMS	3(2-1)

Learning objective:

To learn about solar photovoltaic system components, types, design and performance measurement.

Contents:

An introduction to Photovoltaics, the physics behind the technology, the devices and practical applications, Photovoltaic cells, semiconductor physics, solar cell structures, their principle of operation, design and fabrication. Photovoltaic systems including power converters and energy storage, residential grid-connected photovoltaic systems.

Solar PV system components, types and characteristics, Solar cells type, characteristics and configurations, solar charge controllers, types, characteristics, solar inverters type and characteristics', Solar cables, solar mounting system, solar PV system types; Solar PV off grid, hybrid and on grid systems. Solar photovoltaic applications, solar system performance measurement and monitoring, solar system operation and maintenance.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Duffie, J.A. and W.A. Beckman. 2010. Solar Thermal Engineering, 4th Ed. Wiley and Sons. USA.
2. Kreith, F. and J.F. Kreider. 1978. Principles of Solar Engineering, 2nd Ed. McGraw-Hill, New York
3. Kalodirou, S.A. Solar Energy Engineering: Processes and Systems.
4. Wenham, S.R., M.A. Green., M.E. Watt. And R. Corkish. 2007. Applied Photovoltaics, 2nd Ed. Earthscan, USA.
5. Green, M.A. 1986. Solar Cells: Operating Principles, Technology and System Applications., University of New South wales.
6. Lorenzo, E., G. Araujo. And A. Cuevas. 1994. Solar Electricity: Engineering of Photovoltaic Systems, Earthscans Publications Ltd.

ESE-	BIOFUELS ENGINEERING	3(2-1)

Learning Objectives:

To impart sound knowledge in bio-fuels feed stock, production and processing.

Contents:

Process Machinery-pumps, valves, heat exchangers, cooling towers, centrifuges, compressors, thermal oxidizers, distillation towers, compressors, refrigeration principles and boiler systems. Startup, shutdown, operation and troubleshooting.

Instrumentation and Control-.P& ID terminologies with applied applications, sequence of operation, including residence time, pressures, and temperature seen in various stages of production. Complete design calculations for equilibrium staged separation processes (e.g. distillation, absorption, solvent extraction). Mass transfer fundamentals. Biodiesel Technologies and Regulatory Issues-Investigates the underlying research and reaction processes that are used to produce biodiesel. Studying feedstock options coupled with past and present technologies provides foundational knowledge about the industry. In-depth review of the ASTM Standards for biodiesel and the regularity issues.

Biodiesel Processes Analysis: Overall process of biodiesel production, review of biodiesel chemistry, process engineering, post reaction processing, fuel specification and properties.

Reaction Kinetics and Reactor Design: Kinetic data, determination of rate laws, analysis of complex reaction networks and design of ideal isothermal reactors. Analyze data for heterogeneous catalytic reactions. Design reactor systems for given synthesis with special emphasis on trans-esterification and bio-fermentation feedstock preparation, treatment and recovery of side streams, fuel transportation storage and general plant operations.

Ethanol Process and Separation Technology- Fundamentals process of ethanol production. A process flow Diagram (PFD) of a typical ethanol plant, operation, including residence time, pressures, and the temperatures, Rationale for feedstock and additives used in ethanol processing as well as product and co-product production and use, basic principles of ethanol distillation, evaporation, and dehydration, operating components in a distillation system.

Practical:

The practical work will be based on Theory Work.

Suggested Readings:

1. Dramcho, C.M., N.P. Nhuan. and T.H. Walker. 2008. Biofuels Engineering Process Technology. McGrw Hill, United States.
2. Sila, H. 2003. Chemical Process Engineering Design and Economics. CRC Press, USA.
3. Eugene, A., T. Baumiester. And A. Sadegh. 2006. Standard Hand book for mechanical Engineering, 11th Ed. McGraw Hill Education.
4. Pimentel, D. 2008. Biofuels, Solar, and Wind as Renewable Energy Systems. 1st Ed. Springer Verlag.
5. Drapcho, C.M., N.P. Nhuan. and T.H. Walker. 2008. Biofuels Engineering Process Technology. MC Graw Hill, New York USA.
6. Hiller, E.A. and B.A. Stout. 1985. Biomass Energy: A Monograph, 1st Ed. Texas A&M University Press, College Station, Texas. USA.
7. Mehla, S.K. 2008. Biofuels: Marketing Strategies and Impact on Rural Development. Aavishkar Publishers, and Distributers, Jaipur. India.

	NUCLEAR POWER PLANT ENGINEERING	**3(3-0)**

Learning objective:

Students will learn nuclear power plants layout, its components, design, and protection, implementation and performance analysis.

Contents:

Nuclear Reaction, Fission and Fusion Reaction, Critical Mass Chain Reaction, Moderators, Reactor Control and Cooling, Classification of Reactors, Different Types of Reactors, Radiation Damages, Shielding of Grays Neutrons, Materials For Construction. Thermoelectric Generators: Thermoelectric Effect, Solid State Description of Thermoelectric Effect Analysis and Design of Thermoelectric Generator, Figure of Merit, Device Configuration, Solar and Radioisotope Powered Generators, Applications.

Layout of nuclear power plants; Containment buildings; Primary containment vessels; Structure of reactor core; and mechanical stress in various structures. Description and analysis of power plant systems and components including steam generator, steam dryer and separator,

pressurizer, re-heater, heat exchanger, condenser, demineralizer, pumps ,turbine, generator, cooling tower; Auxiliary cooling systems. Fuel handling mechanisms; Control and mechanisms; Rad waste systems; Electrical Systems;

Reactor grid interface and load following. Basic considerations in nuclear plant design; Components of nuclear power cost; Economic comparison of nuclear and fossil fueled plants; Dual and multipurpose nuclear plants; Future trends in nuclear power cost. Thermoelectric Generators:

Suggested Readings:

1. Rust, J.H. 1979. Nuclear Power Plant Engineering. Haralson
2. El-Wakil, M.M. 1982. Nuclear Energy Conversion. Revised Ed. American Nuclear Society, USA.
3. Pedersen, E.S. 1978. Nuclear Power. Ann Arbor Science.
4. El-Wakil, M.M. 1984. Power Plant Technology, 1st Ed. McGraw-Hill Publishing Company.
5. Lish, K.C. 1972. Nuclear Power Plant Systems & Equipmen,t Illustrated Ed. Industrial Press Inc, New York.USA.

NCRC RECOMMENDATIONS FOR ENERGY SYSTEMS ENGINEERING (UNDER-GRADUATE PROGRAM)

1. The degree nomenclature of Energy Systems Engineering Program will be BS/BSc/BE Energy Systems Engineering.
2. Energy Systems Engineering will be a minimum four year degree program inclusive of mandatory engineering courses of foundation, breadth and depth given in the Energy Systems Engineering curriculum.
3. The Energy Systems Engineering program should be registered as a separate engineering profession with PEC.
4. The PEC is required to legislate for induction of Energy Systems Engineering graduates in both relevant public and private sector of Pakistan.
5. The HEC and PEC need to coordinate in the profession of Energy Systems Engineering degree program for internship and employment generation for the graduates both in relevant public and private sector organizations.
6. The HEC should facilitate the required necessary funding to the universities offering Energy Systems Engineering program as have been facilitating the other engineering degree programs.
7. Keeping in view the Energy Systems Engineering program a new discipline in Pakistan, it is recommended that non-engineering qualified faculty (PhD only) relevant to the specialized area of Energy Systems Engineering should be hired, but not exceeding 25% of the total strength of the program as per in line with PEC policies.
8. Facilities of training to the faculty members in Energy Systems Engineering program be provided by HEC on priority basis.
9. Preference be given by HEC to offer scholarships to the deserving graduates for higher studies in inland and foreign universities.
10. Annual seminars/workshops be organized by the Energy Systems Engineering departments with the financial assistance of HEC for the development and promotion of the discipline of Energy Systems Engineering.
11. Faculty should manage to attend national/international conferences/expo with the financial support from HEC related to the field of Energy Systems Engineering.
12. The energy centers be established to improve the R&D facilities at the universities offering program in Energy Systems Engineering.
13. There should be resource centers established by HEC to improve the HRD requirements at the universities offering program in Energy Systems Engineering.
14. Higher Education Commission should facilitate in establishing required labs at the Universities to strengthen the discipline of Energy Systems Engineering

15. Necessary financial support should be provided by HEC to support and successfully launch this program of Energy Systems Engineering.

ANNEXURE - A

English I (Functional English)

Objectives: Enhance language skills and develop critical thinking.

Course Contents:

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

Comprehension
Answers to questions on a given text

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

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

Translation skills

Urdu to English

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

Presentation skills
Introduction

Note: Extensive reading is required for vocabulary building

Recommended Books:

1. **Functional English**

a) Grammar

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c) Reading/Comprehension

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

d) Speaking

English II (Communication Skills)

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

Course Contents:

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

Essay writing
Introduction

CV and job application

Translation skills
Urdu to English

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

Academic skills
Letter/memo writing, minutes of meetings, use of library and internet

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

Note: documentaries to be shown for discussion and review

Recommended Books:

Communication Skills

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

b) Writing
   1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
   2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

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

English III (Technical Writing and Presentation Skills)

Objectives: Enhance language skills and develop critical thinking

Course Contents:

Presentation skills

Essay writing
Descriptive, narrative, discursive, argumentative

Academic writing
How to write a proposal for research paper/term paper

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

Technical Report writing

Progress report writing

Note: Extensive reading is required for vocabulary building

Recommended Books:

Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing
   1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).

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

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

ANNEXURE - B

Pakistan Studies (Compulsory)

Introduction/Objectives

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

Course Outline

1. **Historical Perspective**

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

   b. Factors leading to Muslim separatism

   c. People and Land
      i. Indus Civilization
      ii. Muslim advent
      iii. Location and geo-physical features.

2. **Government and Politics in Pakistan**

   Political and constitutional phases:
   a. 1947-58
   b. 1958-71
   c. 1971-77
   d. 1977-88
   e. 1988-99
   f. 1999 onward

3. **Contemporary Pakistan**

   a. Economic institutions and issues

   b. Society and social structure

   c. Ethnicity

   d. Foreign policy of Pakistan and challenges

   e. Futuristic outlook of Pakistan

Recommended Books:

1. Burki, Shahid Javed. *State & Society in Pakistan,* The MacMillan Press Ltd 1980.

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

ANNEXURE - C

ISLAMIC STUDIES
(Compulsory)

Objectives:

This course is aimed at:

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

Detail of Courses

Introduction to Quranic Studies

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

Study of Selected Text of Holly Quran

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

Study of Selected Text of Holly Quran

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

Seerat of Holy Prophet (S.A.W) I

1) Life of Muhammad Bin Abdullah (Before Prophet Hood)

2) Life of Holy Prophet (S.A.W) in Makkah
3) Important Lessons Derived from the life of Holy Prophet in Makkah

Seerat of Holy Prophet (S.A.W) II

1) Life of Holy Prophet (S.A.W) in Madina
2) Important Events of Life Holy Prophet in Madina
3) Important Lessons Derived from the life of Holy Prophet in Madina

Introduction to Sunnah

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

Selected Study from Text of Hadith

Introduction to Islamic Law & Jurisprudence

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

Islamic Culture & Civilization

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

Islam & Science

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

Islamic Economic System

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

Political System of Islam

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

Islamic History

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

Social System of Islam

1) Basic Concepts of Social System of Islam
2) Elements of Family
3) Ethical Values of Islam

Reference Books:

1) Hameed ullah Muhammad, "Emergence of Islam" , IRI, Islamabad
2) Hameed ullah Muhammad, "Muslim Conduct of State"
3) Hameed ullah Muhammad, 'Introduction to Islam
4) Mulana Muhammad Yousaf Islahi,"
5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
7) Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
8) H. S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

Annexure "D"

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

COMPULSORY MATHEMATICS COURSES FOR BS (4 YEAR)

(FOR STUDENTS NOT MAJORING IN MATHEMATICS)

1. MATHEMATICS I (ALGEBRA)

Prerequisite(s): Mathematics at secondary level

Credit Hours: 3 + 0

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

Course Outline:

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

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

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

Recommended Books:

1. Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin, Boston (suggested text)

2. Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

2. MATHEMATICS II (CALCULUS)

Prerequisite(s): Mathematics I (Algebra)

Credit Hours: 3 + 0

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

Course Outline:

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

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

Recommended Books:

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

3. MATHEMATICS III (GEOMETRY)

Prerequisite(s): Mathematics II (Calculus)

Credit Hours: 3 + 0

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

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

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

Recommended Books:

1. Abraham S, Analytic Geometry, Scott, Freshman and Company, 1969

2. Kaufmann JE, College *Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

3. Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6th edition), 1986, PWS-Kent Company, Boston

4. COURSE FOR NON-MATHEMATICS MAJORS IN SOCIAL SCIENCES

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

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

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

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

Contents :

1. *Algebra* : *Preliminaries:* Real and complex numbers, Introduction to sets, set operations, functions, types of functions. *Matrices:* Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. *Quadratic equations:* Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. *Sequence and Series:* Arithmetic, geometric and harmonic progressions. *Permutation and combinations*: Introduction to permutation and combinations, *Binomial Theorem:* Introduction to binomial theorem. *Trigonometry:* Fundamentals of trigonometry, trigonometric identities. *Graphs:* Graph of straight line, circle and trigonometric functions.
2. *Statistics* : *Introduction*: Meaning and definition of statistics, relationship of statistics with social science, characteristics of statistics, limitations of statistics and main division of statistics. *Frequency distribution*: Organisation of data, array, ungrouped and grouped data, types of frequency series, individual, discrete and continuous series, tally sheet method, graphic presentation of the frequency distribution, bar frequency diagram histogram, frequency polygon, cumulative frequency curve. *Measures of central tendency*: Mean medium and modes, quartiles, deciles and percentiles. *Measures of dispersion*: Range, inter quartile deviation mean deviation, standard deviation, variance, moments, skewness and kurtosis.

Recommended Books:

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

5. MATHEMATICS FOR CHEMISTRY

Credit Hours: 3

Prerequisites: Mathematics at Secondary level

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

Course Outline:

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

Recommended Books:

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

6. MATHEMATICS FOR PHYSICS

Contents:

1. **Preliminary calculus.**

- Differentiation

  Differentiation from first principles; products; the chain rule; quotients; implicit differentiation; logarithmic differentiation; Leibnitz' theorem; special points of a function; theorems of differentiation.

- Integration

  Integration from first principles; the inverse of differentiation; integration by inspection; sinusoidal function; logarithmic integration; integration using partial fractions; substitution method; integration by parts; reduction formulae; infinite and improper integrals; plane polar coordinates; integral inequalities; applications of integration.

2. Complex numbers and hyperbolic functions

- The need for complex numbers
- Manipulation of complex numbers

  Additions and subtraction; modulus and argument; multiplication; complex conjugate; division

- Polar representation of complex numbers

  Multiplication and division in polar form

- de Moivre's theorem

  Trigonometrical identities; finding the nth roots of unity; solving polynomial equations

- Complex logarithms and complex powers
- Applications to differentiation and integration
- Hyperbolic functions

Definitions; hyperbolic-trigonometric analogies; identities of hyperbolic functions; solving hyperbolic equations; inverses of hyperbolic functions; calculus of hyperbolic functions

3. Series and limits

- Series

- Summation of series

Arithmetic series; geometric series; arithmetico-geometric series; the difference method; series involving natural numbers; transformation of series

- Convergence of infinite series
  Absolute and conditional convergence; convergence of a series containing only real positive terms; alternating series test
- Operations with series
- Power series
  Convergence of power series; operations with power series
- Taylor series
  Taylor's theorem; approximation errors in Taylor series; standard McLaurin series
- Evaluation of limits

4. Partial differentiation

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

5. Multiple integrals

- Double integrals

- Triple integrals

- Applications of multiple integrals

  Areas and volumes; masses, centers of mass and centroids; Pappus' theorems; moments of inertia; mean values of functions

- Change of variables in multiple integrals

Change of variables in double integrals;

6. Vector algebra

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

7. Matrices and vector spaces

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

8. Vector calculus

- Differentiation of vectors
  Composite vector expressions; differential of a vector
- Integration of vectors
- Space curves
- Vector functions of several arguments

- Surfaces
- Scalar and vector fields
- Vector operators
- Gradient of a scalar field; divergence of a vector field; curl of a vector field
- Vector operator formulae
- Vector operators acting on sums and products; combinations of grad, div and curl
- Cylindrical and spherical polar coordinates
- Cylindrical polar coordinates; spherical polar coordinates.

ANNEXURE "E"

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

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

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

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

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

Practical:

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

Recommended Books:

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

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

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

Practical:

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

Recommended Books:

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)

2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad

3. Principles and Procedures of Statistics A Bio-material approach, 2nd Edition, 1980 by R. G. D Steal and James H. Tarric

4. Statistical Procedures for Agricultural Research 2nd Edition (1980) by K. A. Gomez and A. A. Gomez

ANNEXURE – F

Introduction to Information and Communication Technologies

Course Structure: Lectures: 2 Labs: 1 **Credit Hours:** 3

Pre-requisite: **None** **Semester: 1**

Course Description:

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

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

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

Course Contents:

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

Text Books/Reference Books:

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

ANNEXURE-G

FUNCTIONAL BIOLOGY-I CREDIT HOURS 3+0

Biological Methods

Principles of Cellular Life
Chemical Basis
Structure and Function
Principles of Metabolism
Energy Acquisition
Principles of Inheritance
Mitosis and Meiosis
Chromosomes
Observable Inheritance Patterns
DNA Structure and Function
RNA and Proteins
Genes
Genetic Engineering and Biotechnology

Biodiversity
Fundamental Concept of Biodiversity
One or two examples of each of the following from commonly found organism
Prions
Viruses
Bacteria
Protistans
Algae
Fungi
Plants
Crops
Animals
Invertebrates
Vertebrates

Reading:

1. Roberts, M.M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

Functional Biology-II Credit Hours 3+0

Myths and Realities of Evolution

Microevolution
Speciation
Macroevolution

Level of Organization
Plants
Tissues
Nutrition and Transport
Reproduction
Growth and Development

Animals
Tissue, Organ System and Homeostasis
Information Flow and Neuron
Nervous System
Circulation and Immunity
Nutrition and Respiration
Reproduction and Development

Ecology and Behavior
Ecosystems
Biosphere
Social Interactions
Community Interactions
Human Impact on Biosphere
Environment Conservation

Reading:

1. Roberts, M.M., Reiss and G.Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

Note:
Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.