CURRICULUM OF
B.Sc. ENERGY SYSTEMS ENGINEERING
4-YEARS DEGREE PROGRAM

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/m²/day exists in the country over more than 95% of its area. Wind speed 5–7 m/s persist in coastal regions of Sindh and Balochistan provinces and in a number of North West frontier valleys. According to a survey, Pakistan possesses more than 50,000 MW 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.

Program 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 Engineering is an exciting and unique undergraduate program which we are going offer to meet energy crises by opening a new Department of Renewable Energy 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 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/maintaining/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 fundamental engineering courses. Thereafter, one takes a series of courses that strengthen the “Energy Systems Engineering” concept. Fundamental 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.

**Eligibility Criteria for Admission in BSc. Energy Systems Engineering (4-yr degree program)**

FSc (pre-Engineering) with at least 60% pass marks + entry test with at least 50% pass marks in addition to other conditions as per University rules
**BS/BSc/BE Energy Systems Engineering**

- **Duration:** 4 years
- **Number of semesters:** 8
- **Number of weeks per semester:** 16 - 18 (minimum 16 weeks for teaching and 2 weeks for examinations)
- **Total number of credit hours:** 137
- **Number of credit hours per semester:** 14 - 20
## Scheme of Studies of BS/BSc./BE Energy Systems Engineering

### First Semester

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMP-303</td>
<td>Metallurgy &amp; Workshop Practices</td>
<td>4(2-2)</td>
</tr>
<tr>
<td>ID-303</td>
<td>Fluid Mechanics</td>
<td>4(3-1)</td>
</tr>
</tbody>
</table>

**Non-Engineering Courses**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS-202 or SSH-402</td>
<td>Islamic Studies or Ethics (for Non-Muslim students)</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>MATH-301</td>
<td>Linear Algebra &amp; Calculus</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>PY-301</td>
<td>Applied Physics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>CHEM-307</td>
<td>Organic Chemistry</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

**Total Credit hours** 20(15-5)

### Second Semester

**Engineering Courses**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-302</td>
<td>Principles of Energy Engineering</td>
<td>2(2-0)</td>
</tr>
<tr>
<td>FMP-302</td>
<td>Manufacturing Engineering</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SEE-310</td>
<td>Engineering Mechanics</td>
<td>4(3-1)</td>
</tr>
<tr>
<td>SEE-312</td>
<td>Engineering Drawing, Graphics, and CAD</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

**Non-Engineering Courses**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS-401</td>
<td>Computer Programming and Applications in Engineering</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>MATH-401</td>
<td>Differential Equations, Power Series, Laplace Transform</td>
<td>3(3-0)</td>
</tr>
</tbody>
</table>

**Total Credit hours** 18(14-4)

### Third Semester

**Engineering Courses**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-401</td>
<td>Electrical Engineering-I</td>
<td>4(3-1)</td>
</tr>
<tr>
<td>FMP-401</td>
<td>Engineering Thermodynamics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ID-302</td>
<td>Engineering Numerical Analysis</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

**Non-Engineering Courses**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSH-102</td>
<td>Pakistan Studies</td>
<td>2(2-0)</td>
</tr>
<tr>
<td>ENG-101</td>
<td>English Composition and Comprehension</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>RS-401</td>
<td>Sociology for Engineers</td>
<td>2(2-0)</td>
</tr>
</tbody>
</table>

**Total Credit hours** 17(14-3)

### Fourth Semester

**Engineering Courses**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>FMP-406</td>
<td>Instrumentation &amp; Controls</td>
<td>4(3-1)</td>
</tr>
<tr>
<td>SEE-402</td>
<td>Mechanics of Materials</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-402</td>
<td>Heat and Mass Transfer</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

**Non-Engineering Courses**

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Title of the Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEE-302</td>
<td>Communication &amp; Presentation Skills</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>STAT-402</td>
<td>Statistics and Probability</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>BBA-403</td>
<td>Operations Management</td>
<td>3(3-0)</td>
</tr>
</tbody>
</table>

**Total Credit hours** 19(14-5)
### Fifth Semester

<table>
<thead>
<tr>
<th>Engineering Courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-501 Solar Energy Systems</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-503 Wind and Hydropower Conversion</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-505 Electrochemical Engineering Fundamentals</td>
<td>2(2-0)</td>
</tr>
<tr>
<td>FMP-505 Boiler Engineering and Power Plants</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-507 Electrical Engineering-II</td>
<td>3(3-0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Engineering Courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Engineering Elective Course</td>
<td>3(2-1)</td>
</tr>
<tr>
<td><strong>Total Credit Hours</strong></td>
<td><strong>17(13-4)</strong></td>
</tr>
</tbody>
</table>

### Sixth Semester

<table>
<thead>
<tr>
<th>Engineering Courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-502 Hydrogen and Fuel Cells</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-504 Bio-Energy Engineering</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-506 Heating, Ventilation and Air Conditioning Systems</td>
<td>4(3-1)</td>
</tr>
<tr>
<td>ESE-508 RS &amp; GIS for Renewable Energy Resources</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non-Engineering Course</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICRO-501 Microbial Bioenergy and Biofuels</td>
<td>3(2-1)</td>
</tr>
<tr>
<td><strong>Total Credit Hours</strong></td>
<td><strong>16(11-5)</strong></td>
</tr>
</tbody>
</table>

### Seventh Semester

<table>
<thead>
<tr>
<th>Engineering Courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-601 Energy Conservation</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>FMP-607 I.C. Engines</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-603 Project and Report-I</td>
<td>3(0-3)</td>
</tr>
<tr>
<td>Engineering Elective-I</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>Engineering Elective-II</td>
<td>3(2-1)</td>
</tr>
<tr>
<td><strong>Total Credit Hours</strong></td>
<td><strong>15(9-6)</strong></td>
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</table>

### Eighth Semester

<table>
<thead>
<tr>
<th>Engineering Courses</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-602 Power Electronics</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-604 Energy Economics, Policy and Management</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>ESE-606 Project &amp; Report-II</td>
<td>3(0-3)</td>
</tr>
<tr>
<td>Engineering Elective-III</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>Engineering Elective-IV</td>
<td>3(2-1)</td>
</tr>
<tr>
<td><strong>Total Credit Hours</strong></td>
<td><strong>15(10-5)</strong></td>
</tr>
</tbody>
</table>

**Total Credit Hours for B.Sc. Energy Systems Engineering = 137**

**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.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM-405</td>
<td>Photoactive Materials and Their Characterization</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>AGRON-319</td>
<td>Basic Agriculture for Engineers</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>PY-302</td>
<td>Environmental Physics</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

**Engineering Elective-I**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-605</td>
<td>Renewable Energy Engineering</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-607</td>
<td>Petroleum and Gas Exploration</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>ESE-609</td>
<td>Geothermal and Tidal Energy</td>
<td>3(2-1)</td>
</tr>
</tbody>
</table>

**Engineering Elective-II**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-611</td>
<td>Fuels and Combustion</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>SEE-609</td>
<td>Environmental Impact Assessment</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>ESE-613</td>
<td>Theory of Machines</td>
<td>3(2-1)</td>
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</table>

**Engineering Elective-III**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-608</td>
<td>Nuclear Energy Engineering</td>
<td>3(3-0)</td>
</tr>
<tr>
<td>ESE-610</td>
<td>Nano Technology and Energy</td>
<td>3(3-0)</td>
</tr>
</tbody>
</table>

**Engineering Elective-IV**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESE-612</td>
<td>Clean Coal Technology</td>
<td>3(2-1)</td>
</tr>
<tr>
<td>FMP-602</td>
<td>Machine Design</td>
<td>3(3-0)</td>
</tr>
</tbody>
</table>
Learning Objectives
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

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

Learning Objectives
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**

<table>
<thead>
<tr>
<th>ESE-302</th>
<th>Principles of Energy Engineering</th>
<th>2(2-0)</th>
</tr>
</thead>
</table>

**Learning Objectives**
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.


**Suggested Readings**
Learning Objectives
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), weld ability 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:

Learning Objectives
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

Practical
To verify the law of polygon of forces, the law of parallelogram of forces, the principles of moments, the coefficient 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

<table>
<thead>
<tr>
<th>ESE-401</th>
<th>Electrical Engineering-I</th>
<th>4(3-1)</th>
</tr>
</thead>
</table>

**Learning Objectives**
To study and understand the various basic terms of Electrical Engineering and basic Engineering Software

**Contents**
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.

**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.

**Suggested Readings**

<table>
<thead>
<tr>
<th>FMP-401</th>
<th>Engineering Thermodynamics</th>
<th>3(2-1)</th>
</tr>
</thead>
</table>

**Learning Objectives**
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.
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, CO₂, NO₂, 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

ID-302

Engineering Numerical Analysis

Learning Objectives
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

Practical
Numerical solution techniques will be elaborated and demonstrated.

Suggested Readings

Learning Objectives
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 modern 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
Learning Objectives
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

ESE-402  Heat and Mass Transfer  3(2-1)

Learning Objectives
To familiarize the students on different types of heat transfer methods, heat exchangers and their design.

Contents
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
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, Seebeck 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

Learning Objectives
To study and complete understanding of Wind Power Plant and Hydal Power Plant with its basics.

Contents
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,

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

<table>
<thead>
<tr>
<th>ESE-505</th>
<th>Electro Chemical Engineering Fundamentals</th>
<th>2(2-0)</th>
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Learning Objectives
To train the students about the electrochemical engineering fundamentals and various processes.

Contents
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

<table>
<thead>
<tr>
<th>FMP-505</th>
<th>Boiler Engineering and Power Plants</th>
<th>3(2-1)</th>
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</thead>
</table>

Learning Objectives
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, superheated 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

Learning Objectives
The objective of this course is to provide an extensive overview of substations and study of electrical system towards transmission & distribution as well.

Contents
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.

Recommended Books

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

Contents

Practical

Suggested Readings

Learning Objectives
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
### ESE-506  Heating Ventilation and Air Conditioning Systems  4(3-1)

**Learning Objectives**

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 recirculating 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, grills 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.

**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**


### ESE-508  RS & GIS for Renewable Energy Resources  3(2-1)

**Learning Objectives**

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

<table>
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<tr>
<th>ESE-601</th>
<th>Energy Conservation</th>
<th>3(3-0)</th>
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Learning Objectives
Complete understanding of conversion and performance of energy from one form to another.

Contents

Suggested Readings

<table>
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<tr>
<th>FMP-607</th>
<th>I.C. Engines</th>
<th>3(2-1)</th>
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Learning Objectives
Providing instructions relating components of IC engine, tractor components and its mechanics.

Contents
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.


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.


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

Learning 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

| ESE-602    | 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, Thyristor 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.

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

Suggested Readings:

| ESE-604    | Energy Economics, Policy and Management | 3(3-0) |

Learning Objectives
Complete study and understanding of the energy tariffs, energy demand & supply and study of the management of energy with its policy

Contents

Suggested Readings
Learning 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.

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Suggested Readings
Learning Objectives
An introductory course introducing concepts of energy and renewable energy sources.

Contents
History of energy usage, forms of energy, present energy consumption, environmental problems.


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.


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
Learning Objectives
To teach the students about physical and chemical properties and treatment processes of petroleum and gas for commercial applications.

Contents
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

ESE-609 Geothermal and Tidal Energy 3(2-1)

Learning Objectives
To teach the students about the possibility of exploration about geothermal and tidal energy.

Contents

Practical
Laboratory demonstration of Heat source systems; demonstration of 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

ESE-611 Fuels and Combustion 3(2-1)

Learning Objectives
To educate the students about various characteristics and combustion theory of various fossil fuels for energy generation.
Contents

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

Learning Objectives
To teach the students about environmental impact assessment and tools for sustainable development.

Contents

Suggested Readings

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

Learning Objectives
To teach the students about nuclear reactor systems and its application in energy field.

Contents

Suggested Readings

Learning Objectives
To teach the students about new concepts of nano technology in the field of energy sector and its applications.

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**

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<thead>
<tr>
<th>ESE-612</th>
<th>Clean Coal Technology</th>
<th>3(2-1)</th>
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**Learning Objectives**
Complete study of the Coal Technology with its complete processes and its storage as well.

**Contents**
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 coal gasification 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**

<table>
<thead>
<tr>
<th>FMP-602</th>
<th>Machine Design</th>
<th>3(3-0)</th>
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**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**

**Suggested Readings**
APPENDIX

صفر زمین کے جنگل کی طوفانی طوفان کے پہلا پیشرفت ہے اور معاشرتی میکروسکوپ کی بھی ہے۔

بیان انٹرویو کے لیے کومیت پاکستان، اسلام آباد کی سفارشات کی روشنی سے مرتب کر دیا جا گیا

تصباً

Islamic Studies (Compulsory)
for B.A./B.Sc.

مطالعہ علوم اسلامیہ (لازی)

پی اے/ائی این سی
الأسماء المطلقة

في النص

(i) مطلقة اسماء (الزي)

(ii) مطلقة اسماء (الزي)

(iii) مطلقة اسماء (الزي)

محمود اسماء (الزي) كاً كوجهة صغيرة بمجرد مكتوم كمان كرسي مختال لوما. الرؤية كاً كوجهة صغيرة بمجرد مكتوم Keb T MENU
إن الرسول ﷺ قال: «إن عهد الله ﻟى زكريا ﷺ كان، أنه إذا صلى في مسجد الاقصى لم يخرج له أحد إلاً.» (جامع ترمذي، سنن دار القلمي، 2/308)

وعن النبي ﷺ قال: «إن رسول الله ﷺ رأى الله ﻟى الناجر الصدق فيهم، والسبيلين، والصديقين، والشهداء.» (جامع ترمذي، سنن دار القلمي، 2/310)

وعن أبى مسعود ﷺ قال: «إن رسول الله ﷺ رأى الله ﻟى الناجر الصدق فيهم، والسبيلين، والصديقين، والشهداء.» (جامع ترمذي، سنن دار القلمي، 2/310)

وعن عبد الله ﷺ قال: «إنه سمع الله ﻟى عدوه ﻟى عليه ﷺ، إنه سمع الله ﻟى عدوه ﻟى عليه ﷺ، إنه سمع الله ﻟى عدوه ﻟى عليه ﷺ، إنه سمع الله ﻟى عدوه ﻟى عليه ﷺ.» (جامع ترمذي، سنن دار القلمي، 2/310)

وعن أبى سعد ﷺ قال: «إنه سمع الله ﻟى الناجر الصدق فيهم، والسبيلين، والصديقين، والشهداء.» (جامع ترمذي، سنن دار القلمي، 2/310)

وعن أبى هريرة ﷺ قال: «إن رسول الله ﷺ رأى الله ﻟى الناجر الصدق فيهم، والسبيلين، والصديقين، والشهداء.» (جامع ترمذي، سنن دار القلمي، 2/310)
عن عليّ قال: قال رسول الله ﷺ: من ملك زاداً و راحة فيله إلى بيت الله ولم يحج فلا عينه أن يموت يهودياً أو نصرانياً وذلك إن الله دبارك و تعالى يقول وله على الناس جزى البيت من استطاع إليه سبيله. (جامع الرمذي)

عن ابن عباس ﷺ أن النبي ﷺ قال أربع من أعظمهم فقد أعطى خير الدنيا والآخرة فلما شاكراً ونساءً ذاكر وبداً على البلاد صابراً و زوجة لا تحيا في نفسها وماله. (سند ناسائي)

عن أبي هريرة رضي الله عنه أن رسول الله ﷺ قال: أهرون هو المفسر قالوا: المسلم فيما قد لا يفهم له ولا مناهج فقال: إن المفسر من أمتي من يأتي يوم القيامة بصلاة وتخطيط وركه، وأيما قد شتم هذا، وقذف هذا وأكل مال هذا سفك دم هذا، وضرب هذا، فيفطن هذا من حسناته، وهذا من حسناته فإن فيت حسناته قبل أن قضى ما عليه أخذ من خطاباتهم فطرخ عليه ثم طرح في النار.

عن أبي هريرة قال: قال رسول الله ﷺ من آدم الله مالاً فلا يؤذ زكاة مثل ماله يوم القيامة شخصًا أفرع له زينب بن بَطَّوْف بعثت يوم القيامة ثم ذكر بن بتوفه (بيعت شدها)، ثم رأيت أن الله أدرك، ثم لا ولا يحسن الذين يدخلون بما أتى الله من فضله أو خيراً لهم بل هو شروط نسيب لهم سبطاقون ما صنعوا به يوم القيامة. (صحيح البخاري)

عن حبرُة بن ماعب: قال: قال رسول الله ﷺ: مروا اليمين الصالحة إذا بلغ السبع سنين وإذا بلغ عشر سنين فأشربه عليه. أخرج أبو دار الرمذي وفظ عليه الحسب الصالحة، ابن سمع سنين وأشربه عليه ابن عشر. (صحيح البخاري)

قال رسول الله ﷺ: حانوت شر الناس يوم القيامة ذا الوجيه الذي يأتي مولاه يوجه ومولاه يوجه. (متفق عليه: أبي هريرة)

قال رسول الله ﷺ: بياج، بالزوج يوم القيامة فيلقه في النار تنتديأ أنفه في النار فيلفتهم فيها كتفيين الحمام برحاء فيجعل أهل النار عليه فيقولون: أي فلان ما شاءك! أي ليس كنت قامرأ بالمعرف وفهمها، قال: كنت أكرك ولا آتيك وأنا كمن المنكر وأنا

عن أبي هريرة قال: قال رسول الله ﷺ: من سلك طريقًا يلقيه علامة في سبيل الله له بطرق إلى الجنة، وما إخراج قوم في بيت من بيوت الله ينزلون كتاب الله فيه يذكرون بينهم إلا نزل عليهم السكينة وطغتهم الرحمة وحفظهم الملكة وذكريمهم الله فين عده ومن بطش عمله لم يسرع به

نصبه (مسلم)
قال رسول الله ﷺ إن أقبل شئ يوضع في ميزان المؤمن يوم القيامة خلق حسن، وإن الله يغلي
الفاحش البذيء (توضيحي أبو الدرداء) عن عمر بن الخطاب قال: قال رسول الله ﷺ حين سأله عن الإيمان أن تؤمن بالله وملائكته وكتبه ورسولله ويوم الآخر وؤمن بالقدر خيره وشره (متفق عليه)
عن العباس بن عبد المطلب قال: قال رسول الله ﷺ ذاك طعم الإيمان من رضى بالله وبدين وصالح ورسول الله ﷺ
عن أصبه قال: قال رضوان الله ﷺ والذي نفسي بيده لا يؤمن عبد حتى يحب لا خبيه ما يحب نفسه (متفق عليه)
عن النعمان بن بشير قال: قال رسول الله ﷺ نرى المؤمنين في تراحمهم وترحالهم وتعاطفهم كمثل
الجسد إذا اشتكى مرضعه فساعده له سائر الجسد بالسهر والحمى (متفق عليه)
عن ابن عمر رضي الله عنه قال: قال رسول الله ﷺ بني الإسلام على خمس شهادة أن لا إله إلا
الله وأن محمداً برهنه ورسوله وإقام الصلاة وإياء الزكاة والحج وصوم رمضان (متفق عليه)
عن أبي سعيد الخدري عن رسول الله ﷺ قال: من رأى منكم متكأ فليقعروه بنده فان لم يمسط
فيساعده إن لم يستطع فقبله وذلك أضعف الإيمان (رواه مسلم)
عن عبد الله بن عمر قال: قال رسول الله ﷺ إلا كلكم رأى وكلكم مسئول عن رعيته قال الإمام الذي
على الناس راعى وهو مسئول عن رعيته والرجل راعى على أهل بيتها وهو مسئول عن رعيته والمرأة
راعية على بيت زوجها وولدها فهي مسئولة عنهم وعبد الرجل راعى على رضاه وهو مسئول عنه ألا
فكلكم راع وكلكم مسئول عن رعيته (متفق عليه)

إثبات

(1) مطالب مبارك في شرارة داود
(2) تركين فرس تيرب وفتيت كراحيه
(3) آمانت سرنا كراحيه
(4) خذن في كل مسيرة أثرناه حتى انثرنا وامرأ
(5) قرأنا مبتدئ بيرصود على سماك
(6) فرذات نوى - مقام وحك
تہذیب و فحران:
تہذیب کا سلسلہ اسلامی تہذیب کی محصوریات
بخش معاشرت
قدسی اطلاعات - درکل اطلاعات
طقسی اخلاقیات - تنہائی اخلاقیات - تربیت اخلاقیات - قرآنی اخلاقیات - عالمی اخلاقیات - ایکت طاقب
بیانی اخلاقیات - خصوصی اخلاقیات - خوشنواستی اخلاقیات
تہذیب اسلامی کے ارتقاء میں سماویت کا کردار

درج ذیل علم و مباحث نئے مسالہ و سماویت کی ضرورت کا احتمال پاتا ہے:

گھی طویل - مہجٹی طویل - معاشری طویل - انٹرنیٹ سیاسی (آئرشائرے سیاسی) - جامعات - زراعت

پوری کتاب:

1. غورھیں اخلاق
2. اسلامی معاشری اخلاق
3. غلامی و فتح
4. سیاسی طویل
5. غازی نمازی
6. پینت کا احتمال

5. Hameed ullah

Introduction to Islam
**Learning Objectives**
To learn fundamentals of algebra & calculus.

**Contents**

Integral calculus: limit of sum, Riemann integration, evaluating integrals, definite integrals, area under a curve and other applications of integration.

**Suggested Readings**

**Learning Objectives**
The purpose of the Applied Physics is to explain natural phenomena. The theories of Physics either exist or go into non-existence by the sword called “Experiment”. Applied Physics deals with learning of how to measure the physical quantities with skill and systematic observation.

**Contents**

**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, planimeter.
9. Fabrication of full wave rectifier and inductance study of its wave-shape.

Suggested Readings

CHEM-307  Organic Chemistry  3(2-1)

Learning Objectives
To give profound concept about the role of organic chemistry in energy systems. Students will be able to learn about organic energy sources and their chemistry in depth.

Contents
Introduction to organic chemistry, organic energy systems and their environmental impacts, renewable and non-renewable energy sources.
Biofuels (biodiesel, bioethanol, biomethanol): Introduction, synthesis and physiochemical characteristics.
Fossil fuels; Introduction, historical background, mining of petroleum, fractional distillation, detailed chemistry and characteristics (octane number, cracking etc.) of petrol, Diesel, Gasoline, Kerosine oil, Terpene Oil and Furnace oil; Liquid Petroleum Gas, Compressed Natural Gas, their chemistry and characteristics, Organic Fuel cells; Introduction, Classification, reactions and Configurations

Practical
1. Trans-esterification of vegetable oil
2. Separation of organic compounds by distillation
3. Synthesis of bioethanol
4. Determination of calorific value of fuel
5. Estimation of sulphur contents of fuel
6. Assessment of flash point of fuel
7. Measurement of Density of fuel
8. Measurement of viscosity of fuel
9. Other practical related to the topic covered in theoretical part and fields Visits.

Suggested Readings

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

Learning Objectives
To familiarize the student with the basic computer language and its application in modern technique

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. Dietel, P and Harvey, D. 2012. C How to Program. 7th Ed. Prentice Hall, USA.

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

Learning Objectives
To teach the students about differential equations, power series and Laplace transform and its application in engineering design field.

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

SSH-102 | Pakistan Studies | 2(2-0)
Learning Objectives
To teach the students about ideology and constitutional development in Pakistan.

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

| ENGL-101 | English Composition and Comprehension | 3(3-0) |

Learning Objectives
To teach the students about English composition and comprehension skills to improve communication skills.

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
2. Ahmad, A. 2009. To The Point (English Grammar & composition for degree), To the point publishers, Yousaf Market, Ghazni Street, Urdu Bazar, Lahore.

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

Learning Objectives
To teach the students about sociology and community development methodologies.

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


Learning Objectives
To teach the students about different communication and presentation skills for leadership qualities.

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


Learning Objectives
To teach the students about different statistical and probability tools and its applications.

Contents
Practical
1. Simple, Multiple and Component bar diagram.
2. Histogram, 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.
10. Test of significance of association of attributes by $x^2$-test (chi-square test).
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.

Suggested Readings

BBA-403 Operations Management 3(3-0)

Learning Objectives
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.
Suggested Readings


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

principles as well as the characterization of solar cells. In the practical domain the use of potentiostat and cyclic voltammetry is prime importance.

Contents

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

Suggested Readings

AGRON-319 Basic Agriculture for Engineers 3(2-1)

Learning Objectives
To familiarize students with the basic concepts of crop husbandry.

Contents
Agriculture-history, importance and branches, allied sciences, impact of climate of Pakistan on crop production. Area under crop production, Basic inputs of agriculture for crop production viz; biological, hydrological, chemical, and mechanical inputs. Land resources and their utilization in Pakistan. Principles of crop production. Tillage: its objectives and types. Cropping systems and crop rotations, Irrigation systems. Production technology of major and minor crops. Classification of field crops w.r.t their food value. Techniques and practices for enhancing crop productivity.

Practical
Identification of various soil types; Demonstration of various irrigation methods; Demonstration and use of tillage implements, seedbed preparation and intercultural operations; Identification of various crops and their seeds w.r.t food value; Demonstration of improved sowing methods; Visits to grain storage facilities and progressive farms; Raising nursery for transplanting seedlings of non-traditional / regional crops; study of medicinal crops and organic farming.

Suggested Readings
Learning Objectives
The course provides an introduction to the physical principles that underlie environmental issues and their relationship with different types of interactions with energy and matter.

Contents
Introduction to environmental physics; Global climate and climatic change; Light pollution; Ozone and UV light; Energy transfer; Radiation, convection and conduction; Thermal regimes of soil profiles; Energy balance; Components and equation; Transport of pollutants in soil and atmosphere; Noise pollution; Sources, types and effects on human health; Management of noise pollution; Ambient air quality; Related issues and measures; Aerosols: Types, sources and health effects; Indoor perspectives of aerosol physics; Radioactivity and nuclear waste management.

Practical
Measurement of noise at different locations to assess the noise pollution; Measurement of light intensity at different locations and times: Measurement of aerosol pollution; Field visits.

Suggested Readings