Elements of Mechanical Engineering
SYLLABUS

Subject Code: 18EME15/25 IA Marks: 40
Hours/Week: 04 Exams. Hours: 03
Total Hours: 50 Exams. Marks: 60

Course Objectives:

Students belonging to all branches of Engineering are made to learn certain fundamental topics related to mechanical engineering so that they will have a minimum understanding of mechanical systems, equipment and process.

Module - 1

Energy Resources: Non-renewable and renewable energy resources, Petroleum based solid, liquid and gaseous fuels, Calorific values of fuels, Combustion and combustion products of fuels,

Solar Power: Solar Radiation, Solar constant (definition only), Solar Thermal energy harvesting, ex: liquid flat plate collectors, solar ponds (principle of operation only), Solar photovoltaic principle. **Wind Power:** principle of operation of a typical windmill. **Hydro Power:** Principles of electric power generation from hydro power plants, **Nuclear Power:** Principles of Nuclear power plants, **Bio Fuels:** introduction to bio fuels, examples of various biofuels used in engineering applications, Comparison of biofuels with petroleum fuels in terms of calorific value and emission.

Steam Formation and Properties: Classification of boilers, Lancashire boiler, Babcock and Wilcox boiler, boiler mountings and accessories (No sketches for mountings and accessories), wet steam, saturated and superheated steam, specific volume, enthalpy and internal energy. (No numerical problems in this module) **10 Hours**

Module- 2

Turbines and IC Engines and Pumps

SteamMturbines – Classification, Principle of operation of Impulse and reaction turbines, Delaval's turbine, Parson's turbine. (No compounding of turbines).

Gas turbines: Classification, Working principles and Operations of Open cycle and closed cycle gas turbines.

Water turbines- Classification, Principles and operations of Pelton wheel, Francis turbine and

Kaplan turbine

Internal Combustion Engines

Classification, I.C. Engines parts, 2 Stroke and 4 stroke Petrol engines, 4 stroke diesel engines. P-V diagrams of Otto and Diesel cycles. Problems on indicated power, brake power, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, and specific fuel consumption

[**Numerical on IC Engines]** **10 Hours**

Module -3

Machine Tools and Automation
Machine Tools Operations:

Turning, facing, knurling, Thread cutting, Taper Turning by swivelling the compound rest, Drilling, Boring, Reaming, Tapping, Counter Sinking, Counter Boring, -Plane milling, End milling, Slot milling. (No sketches of Machine tools, sketches to be used only for explaining operations. Students to be shown the available machine tools in the Machine Shop of the college before explaining the operations)

Robotics and Automation:
Robotics: Introduction, classification based on robots configuration; Polar, cylindrical, Cartesian

Coordinate and spherical. Application, Advantages, and disadvantages

Automation: Definition, types –Fixed, Programmable & Flexible automation, NC/ CNC machines:

Basic elements with simple block diagrams, advantages and disadvantages. **10 Hours**

Module - 4

Engineering materials and joining processes:
Engineering Materials: Types and applications of Ferrous & Nonferrous metals and alloys, Composites: Introduction: Definition, Classification and applications (Air craft and Automobiles)

Soldering, Brazing and Welding:

Definitions, classification and method of soldering, Brazing and welding. Differences between

soldering, Brazing and Welding. Description of Electric Arc Welding and Oxy-Acetylene Welding. **10 Hours**

Module – 5

Refrigeration, Air-Conditioning

Refrigerants: properties of refrigerants, list of commonly used refrigerants. Refrigeration –

Definitions – Refrigerating effect, Ton of Refrigeration, Ice making capacity, COP, Relative COP, unit of Refrigeration. Principle and working of vapor compression refrigeration and vapour absorption refrigeration: Principles and applications of air conditioners, Room air conditioner.

10 hours

Course outcomes:
Students shall demonstrate the Knowledge associated with,

1. Various Energy sources, Boilers, Prime movers such as turbines and IC engines, Refrigeration and air-conditioning systems

2. Metal removal process using Lathe, drilling, Milling Robotics and Automation.

3. Fair understanding of application and usage of various engineering materials.

Scheme of examination:
• Two full questions (with a maximum of four sub questions) of twenty marks each to be set from each module. Each question should cover all the contents of the respective module.

• Students have to answer five full questions choosing one full question from each module

Text Books:
1. V.K.Manglik, "Elements of Mechanical Engineering", PHI Publications, 2013. (Module-1, 2, 4, 5)

2. Mikell P.Groover, "Automation, Production Systems & CIM", 3rd Edition, PHI (Module -3)

3. K.R.Gopalkrishna, "A text Book of Elements of Mechanical Engineering"-Subhash Publishers, Bangalore. (Module -1, 2, 3, 4, 5)

Reference Books:
1. S.TrymbakaMurthy, "A Text Book of Elements of Mechanical Engineering", 4th Edition 2006, Universities Press (India) Pvt Ltd, Hyderabad.

2. K.P.Roy, S.K.Hajra Choudhury, Nirjhar Roy, "Elements of Mechanical Engineering", Media Promoters & Publishers Pvt Ltd,Mumbai,7th Edition,2012

3. Pravin Kumar, "Basic Mechanical Engineering", 2013 Edition, Pearson.

CONTENTS

Module - 1

Energy Resources

There are nine major areas of energy resources. They fall into two categories: nonrenewable and renewable. Nonrenewable energy resources, like coal, nuclear, oil, and natural gas, are available in limited supplies. This is usually due to the long time it takes for them to be replenished. Renewable resources are replenished naturally and over relatively short periods of time. The five major renewable energy resources are solar, wind, water (hydro), biomass, and geothermal.

Since the dawn of humanity people have used renewable sources of energy to survive wood for cooking and heating, wind and water for milling grain, and solar for lighting fires. A little more than 150 years ago people created the technology to extract energy from the ancient fossilized remains of plants and animals. These super-rich but limited sources of energy (coal, oil, and natural gas) quickly replaced wood, wind, solar, and water as the main sources of fuel.

Fossil fuels make up a large portion of today's energy market, although promising new renewable technologies are emerging. Careers in both the renewable and nonrenewable energy

industries are growing; however, there are differences between the two sectors. They each have benefits and challenges, and relate to unique technologies that play a role in our current energy system. For a range of reasons, from the limited amount of fossil fuels available to their effects on the environment, there is increased interest in using renewable forms of energy and developing technologies to increase their efficiency. This growing industry calls for a new workforce.

Renewable Energy sources: Defined as the energy resources which are produced continuously in nature and are essentially inexhaustible at least in the time frame of human societies.

1. Ex: Direct solar energy
2. Wind energy
3. Tidal energy
4. Hydel energy
5. Ocean thermal energy

Non-Renewable Energy sources: defined as the energy resources which have been accumulated over the ages and not quickly replenish able when they are exhausted.

1. Ex: Fossil fuels
2. Nuclear fuels

NUCLEAR FUELS

- ❖ Alternative source of energy.
- ❖ Uranium is the main element required to run a nuclear reactor.
- ❖ Nuclear fission or fusion will produce tremendous amount of heat energy.

Nuclear fusion: Fusion energy is a form of nuclear energy released by the fusion (combustion) of two light nuclei (i.e. nuclei of low mass) to produce heavier mass.

$$4_1H^1 \rightarrow 2He^4 + 2_{+1}e^0$$

Nuclear fission:

$$_{92}U^{235} + {}_0N^1 \rightarrow {}_{56}Ba^{137} + {}_{56}Kr^{97} + 2_0N^1 + \text{Energy}$$

- Nuclear fission is the process, where a heavy nucleus splits into two fragments of more or less of equal mass.

- Neutron + Heavy nucleus → Fission fragments + Neutrons (2 to 3) + energy
- The energy released by fission of I gram of U-235 is equal to that due to combustion of 50 million tons of coal ; it is about 8.5 x 10^{10} J.

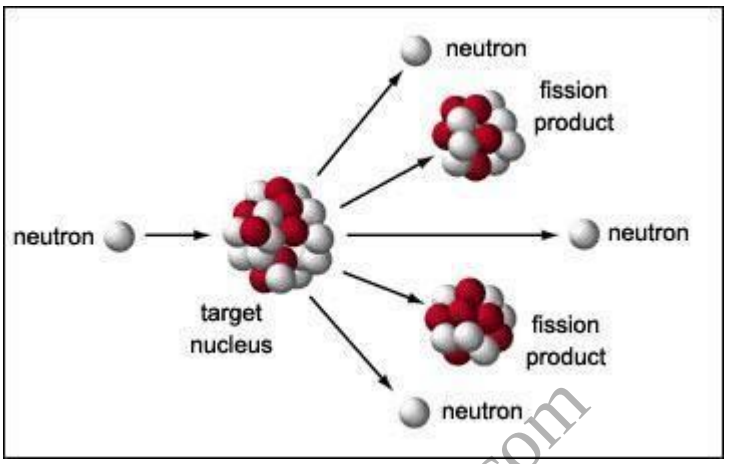

Figure 1: Nuclear fission

NUCLEAR REACTOR

- A nuclear reactor is a device which controls the nuclear fission chain reaction to hardness nuclear energy for peaceful purposes.
- A nuclear reactor which is used t generate electricity, is called a nuclear power plant.
- Fuel in the form of pellets is enclosed in several tubular claddings of steel or aluminum. This is called fuel assembly. Enriched U-235 or Pu-239 is the fuel material.
- A coolant is circulated through the reactor to remove the heat generated. Ordinary water is most commonly used coolant.
- Rods made of boron or cadmium which are neutron absorbers are used as control rods. The neutrons available for fission are controlled by moving the control rods in and out of the nuclear core. The rods can be used to shut down the reactor.

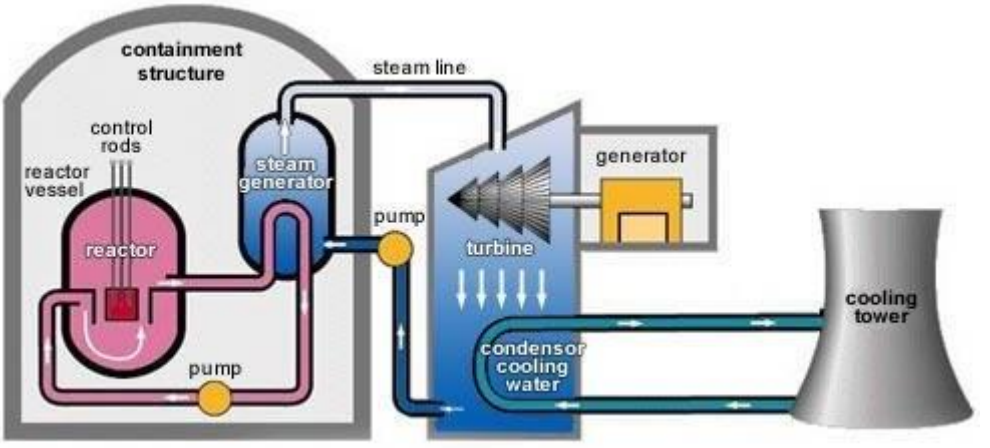

Figure 2: Nuclear reactor

- Heat produced during fission process is absorbed by the coolant and is used to convert water in to steam in the heat exchanger. The steam is used to rotate the steam turbine. The steam turbine is connected to a generator which generates electricity.
- The entire reactor is enclosed in a concrete building with lead sheets covered inside to prevent radioactive radiations being released in to the environment.

Steam Formation and Properties:

Steam Boilers:

Steam boiler is a closed vessel, which is used to convert water into steam at required temperature and pressure by the application of heat.

Classification of Boilers:

1) Horizontal, vertical or inclined
2) Fire tube boiler & water tube boiler
3) Internally fired & externally fired boiler
4) Forced circulation & natural circulation
5) High pressure boiler & low pressure boiler
6) Single tube & multi tube boiler
7) Stationary & portable (locomotive) boiler

Lancashire Boiler:

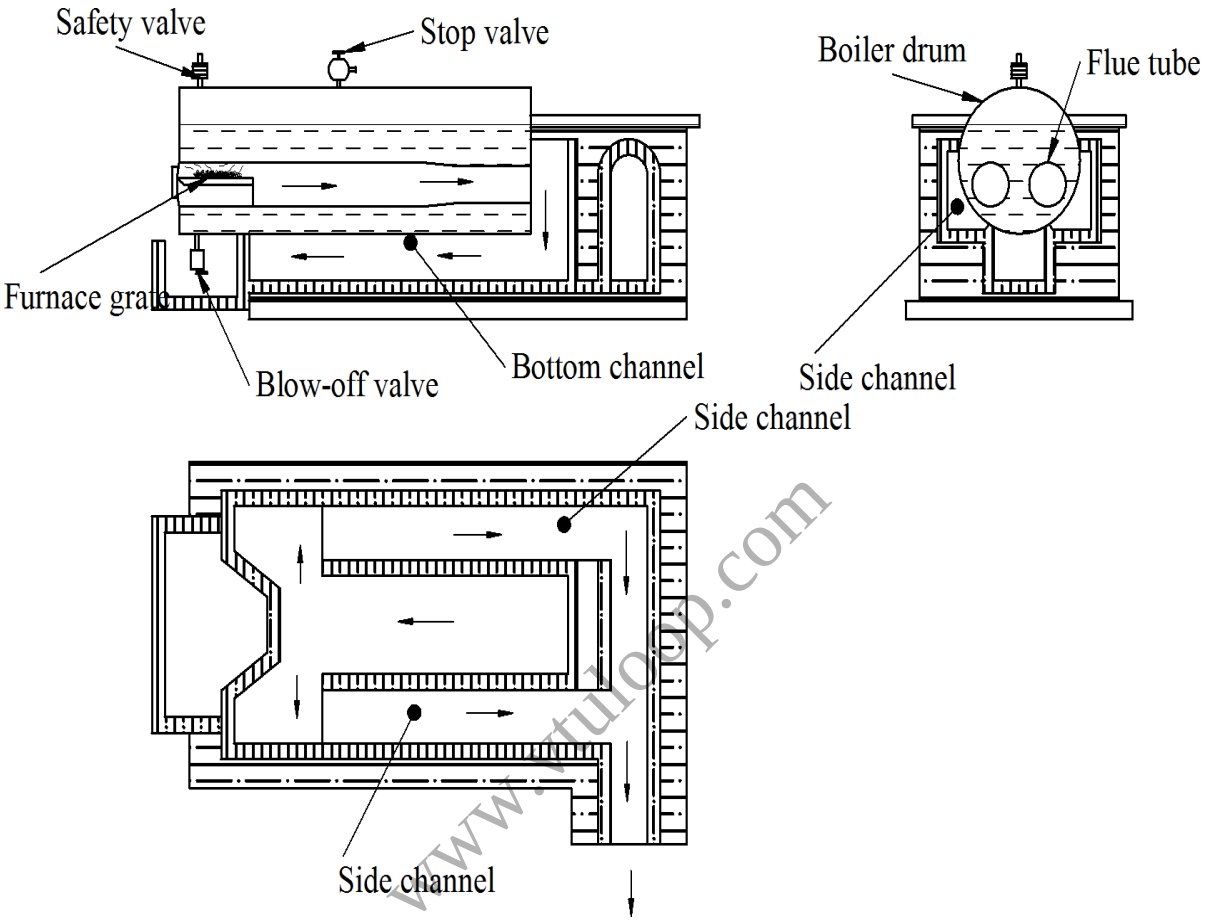

Figure :Lancashire Boiler

Babcock & Wilcox Boiler:

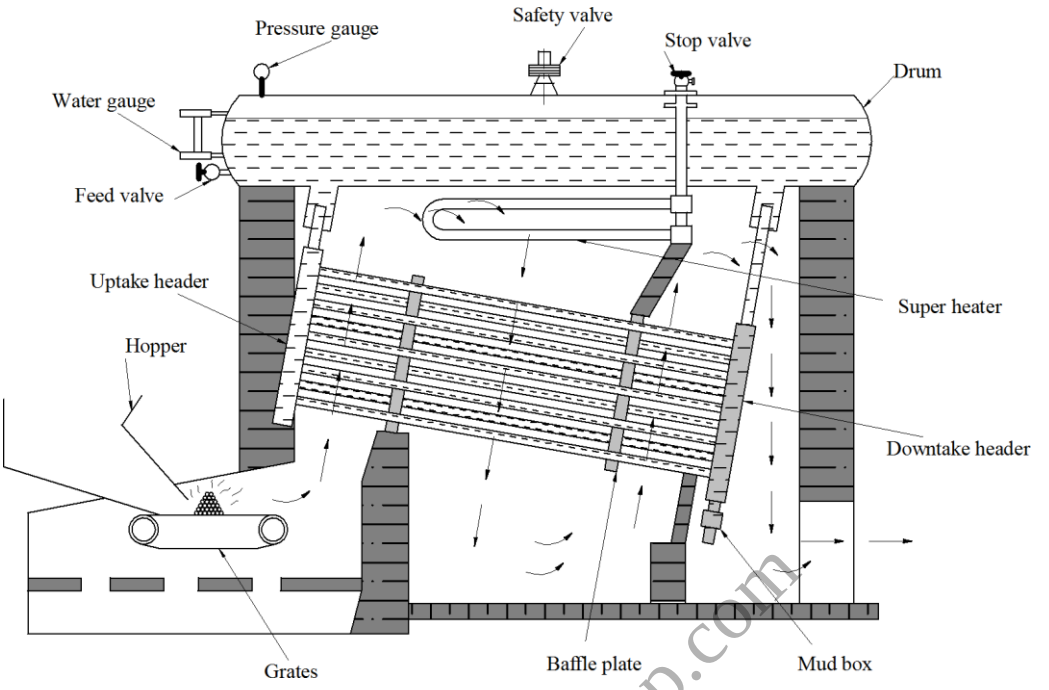

Figure :Babcock & Wilcox Boiler

Boiler mountings:

The boiler mountings are necessary for the proper function & safety of a boiler.

- Safety valve
- Water level indicator
- Pressure gauge
- Blow off valve
- Steam stop valve
- Feed check valve

Boiler accessories:

Boiler accessories are auxiliary parts used in steam boilers for their proper functioning and to improve the efficiency of the power plant.

- Super heater
- Economizer
- Air pre-heater
- Steam separator
- Steam trap