AJAY KUMAR GARG ENGINEERING COLLEGE, GHAZIABAD
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING
SESSIONAL TEST – 2

Course: B. Tech
Session: 2017-18
Subject: Power Station Practice
Max. Marks: 50

Semester: VII
Section: EN-1, 2
Sub. Code: NEN 702
Time: 2 hour

Model Solution

SECTION-A

Ques-1(a) Why is the moderator necessity in a reactor?

Ans The moderator, which is of importance in thermal reactors, is used to moderate, that is, to slow down, neutrons from fission to thermal energies. The probability that fission will occur depends on incident neutron energy. Physicists calculate with fission cross-section, which determines this probability. The probability of the fission U-235 becomes very large at the thermal energies of slow neutrons.

Ques2(b) Differentiate between four stroke & two stroke engine

Ans In 2-stroke engine, the whole sequence of events i.e. suction, compression, power & exhaust are completed in two strokes of piston i.e. one revolution of crankshaft. In 4-stroke engine, all the four events (suction, compression, Power & exhaust) take place inside the engine cylinder. The 4 events are completed in 4 strokes of the piston i.e. two revolutions of the crankshaft.

Qus-13) Write some applications of gas turbine plants.

Ans. Gas turbines can be used for large scale power generation. Examples are applications delivering 600 MW or more from a 400 MW gas turbine coupled to a 200 MW steam turbine in a co-generating installation. Such installations are not normally used for base load electricity generation, but for bringing power to remote sites such as oil & gas fields. They do however find use in the major electricity grids in peak shaving applications to provide emergency peak power.

- Peak load plants
- Base load plants.
- Auxiliary power plant for thermal stations

Qus-14) What is diversity factor? Why is it important?

Ans. Diversity factor is the ratio of the sum of the individual max demands of the various subdivisions of a system (or part of a system) to the maximum demand of the whole system (or part of the system) under consideration. Diversity is usually more than one. Diversity occurs in an operating sys bcoz all loads connected to the sys are not operating simultaneously or are not simultaneously operating at their max rating. The diversity factor shows that the whole electrical load does not equal the sum of its parts due to this time interdependence.

Qus-15) What is depreciation reserve? Why is it necessary to maintain it.

Ans. Depreciation reserve is a business fund in which the probable replacement cost of equipment is accumulated each year over the life of the asset

It can be replaced readily when it becomes obsolete and totally depreciated. It is the total depreciation charged against all productive assets as stated on the balance sheet.

SECTION-B

Ques-6
(a) What are the causes & effects of low power factor? Explain the method of power factor improvement using synchronous condensers.

Ans As uncorrected power factor causes power sys losses in your distribution sys. As power losses increase voltage may drop. Excessive voltage drops can cause overheating & premature failure of motors & other inductive equipment.

⇒ Causes of low Power factor:-

- Single phase & 3-φ Induction Motors :- Usually, IM works at poor power factor i.e. at:
  Full load, Pf = 0.8 - 0.9
  Small load, Pf = 0.2 - 0.3
  No load, Pf may come to zero (0)
- Varying load in Power system:-
- Industrial heating furnaces.
- Electrical discharge lamps.
- Transformers.
- Harmonic currents

⇒ Effects of Low Power factor:-

- Higher current is required by the equipment due to which the economic cost of the equipment is increased
- At low power factor, the current is high which gives rise to high copper losses in the sys & therefor the efficiency of the system is reduced.

- Higher current produced a large voltage drop in the apparatus. This results in the poor voltage regulation.
- Since both the capital & running cost are increased, the operation of the sys at low power factor (whether it is lagging or leading) is uneconomical from the supplier's point of view.

⇒) Power factor improvement using synchronous condenser

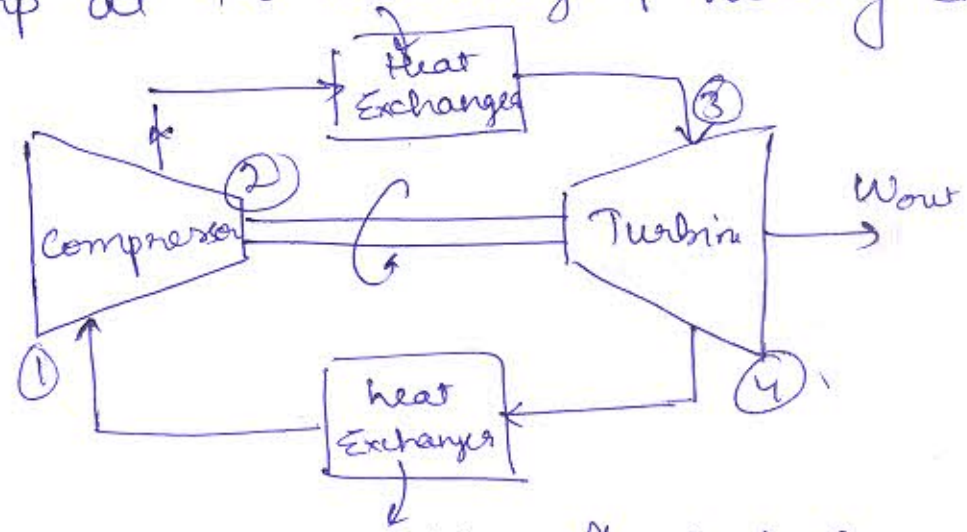
When a synchronous motor operates at No-load & over-excited then it is called a synchronous condenser. Whenever a synchronous motor is over-excited then it provides leading current & works like a capacitor. When a synchronous condenser is connected across supply voltage (in parallel) then it draws leading current & partially eliminates the reactive component & this way, power factor is improved. Generally, synchronous condenser is used to improve the power factor in large industries.

Que. 7(b) Draw a diagram & explain the closed cycle gas turbine plant. Compare the Gas turbine plants with steam plants.

Ans. Closed cycle gas turbine engines are usually used in nuclear power stations & also used as standby power unit for the hydro electric power stations. Compressor, turbine, heat exchanger for heating the working fluid termed as heating chamber & heat exchanger for cooling the working fluid termed as cooling chamber are the main components of closed cycle gas turbine engine.

Open cycle gas turbine engine could be modelled as closed cycle gas turbine engine. Combustion process will be replaced here by constant pressure heat

addition from an external source in heating chamber & discharge process will be replaced by constant pressure heat rejection in cooling chamber.
Air will enter in to the compressor, where pressure & temperature of air will be increased. Now air at high pressure & high temperature will enter to the heating chamber. Working fluid i.e. high press & high temp air will be heated from an external source in heating chamber. High temp nuclear rods are used there for heating the working fluid i.e. air. Hence working fluid i.e. air will have high pressure & high temp at the discharge of heating chamber



⇒ Comparison b/w Gas turbine Plant & Steam plant:-

Gas Turbine Plant	Steam Power Plant
1) In gas turbine the compressor & combustion chamber are the important components.	In steam turbine the steam boiler & accessories are the important components.
2) Less space for installation is required	More space for installation is required.
3) less installation & running cost	3) More installation & running cost
4) A gas turbine does not depend on water supply	Steam turbine depends upon water supply.
5) Its efficiency is less	Its efficiency is high.

Ques 8 (a) Write a short note on 'Shielding against Nuclear Radiations'. Explained Advanced Gas Cooled Reactor (AGR) in detail with their diagram.

Ans Radiation shielding simply means having some material b/w the source of radiation & you (or some device) that will absorb radiation. the amount of shielding required, the type or material of shielding strongly depends on several factors. We are not talking about any optimisation. In fact in some cases an inappropiate shielding may even worsen the radiation situation instead of protecting people from the ionizing radiation.

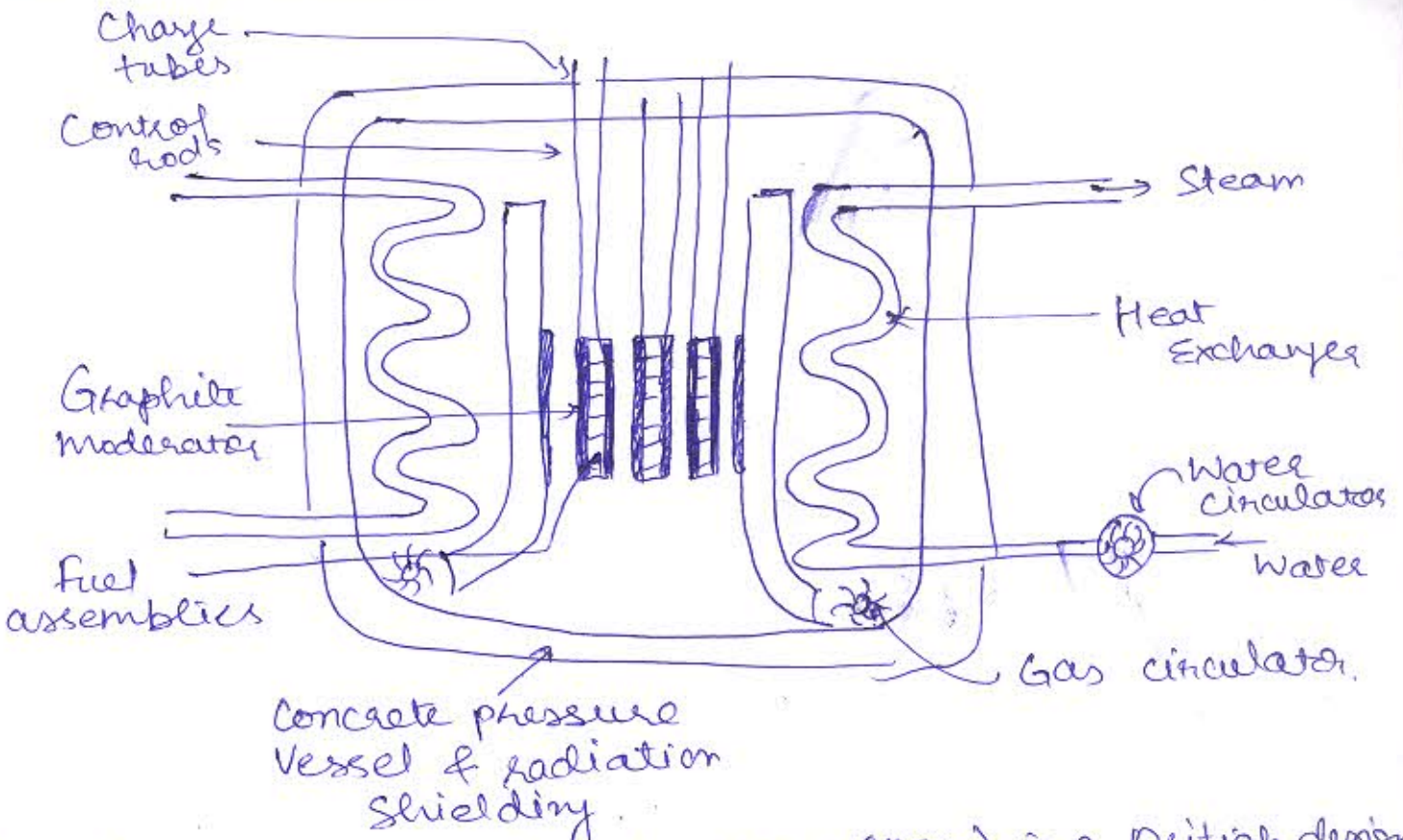
Basic factors which have to be considered during Proposal of Radiation shielding are:-

- Type of ionizing radiation to be shielded.
- Energy spectrum of the ionizing radiation.
- Length of exposure.
- Distance from the source of ionizing radiation
- Requirements on the attenuation of the ionizing radiation
- Design degree of freedom.
- Other physical requirements

The various materials used for shielding are:-

Lead
Concrete
Steel.
Cadmium.

⇒ Advanced Gas Cooled Reactor :- (AGR)



An advanced gas cooled reactor (AGR) is a British design of nuclear reactor. AGRs are using graphite as the neutron moderator & CO_2 as coolant. AGRs were developed from the Magnox type reactor. These are the second generation of British gas cooled reactors. AGRs are operating at a higher gas temperature for improved thermal efficiency, thus requires stainless steel fuel cladding to withstand the higher temperature. Bcoz the stainless steel fuel cladding has a higher neutron capture cross section than Magnox fuel low enriched uranium fuel is needed.

The fuel is uranium oxide pellets, enriched to 2·5-3·5% in stainless steel tubes. The CO_2 circulates through the core, reaching 650°C and then past steam generator tubes outside it, but still inside the concrete & steel pressure vessel (hence 'integral' design.) Control rods penetrate the moderator and a secondary shut down system involves injecting nitrogen to the coolant.

Qus 9 (a) A generating station has a max demand of 25MW, a load factor of 60%, a plant capacity factor of 50% and a plant use factor of 72%. Calculate

- The reserve capacity of the plant
- The daily energy produced
- Max energy that could be produced daily if the plant while running as per schedule were fully loaded.

Ans Load factor = Average Demand / Max Demand

Average Demand = $0.6 * 25 = 15$ MW.

Plant Capacity factor = Average Demand / Plant Capacity

Plant Capacity = $15/0.5 = 30$ MW

(i) Reserve Capacity = Plant capacity - Max Demand

$= 30 - 25 = 5$ MW.

(ii) Daily Energy Produces = Average Demand * No. of hours in a day

$= 15 * 24 = 360$ MWh.

(iii) Max energy that could be produced when plant is running as full load

= Actual energy produced in a day / Plant use factor

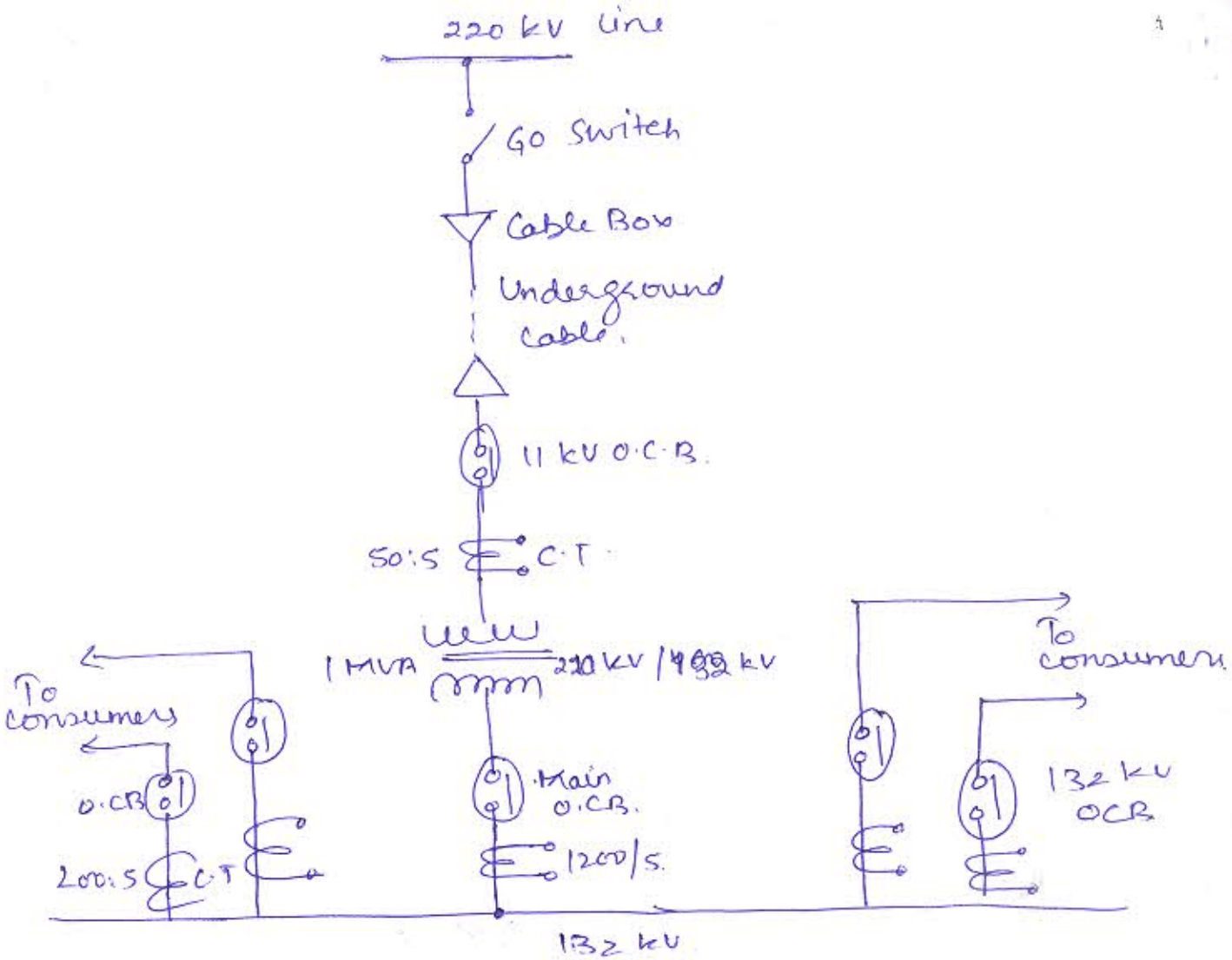
$= 360/0.72 = 500$ MWh/day.

Qus 10 (a) Explain the different types of substation. Draw a typical layout of 220/132 kV Substation.

Ans. The substation is the medium of transferring the power from generating unit to the consumer end. It consists different types of equipment like t/f, generators, power cable which helps in the power transmission.

⇒ Classification of Substation :- The substations may be classified in numerous ways, such as by nature of duties, service ~~reduced~~ rendered operating voltage, importance & design.

- Classification of Substations by Nature of Duties:-
  1) Step-up or Primary Substations
  2) Step down or Distribution Substations
- Classification of Substations by Service Rendered:-
  1) Transformer substations
  2) Switching Substations
  3) Converting Substations
- Classification of Substations by Operating Voltage
  1) High Voltage Substations
  2) Extra high Voltage substations.
  3) Ultra high Voltage.
- Classification of Substation by Importance
  1) Grid substation
  2) Town Substation.
- Classification of Substation by Design
  1) Indoor Type Substations.
  2) Outdoor Type Substations.
  3) Pole Mounted Substations
  4) foundation Mounted Substation



SECTION-C

Ques: 11

(a) Discuss the operation of Diesel Power Plant in brief. Discuss the advantages, disadvantages & fields of application of diesel electric plant.

Ans: For generating electrical powers, it is essential to rotate the rotor of an alternator by means of a prime mover. The prime mover can be driven by different methods. Using diesel engine as prime mover is one of the popular methods of generating powers. When prime mover of the alternators is diesel engine, the power station is called diesel power station.

⇒ Different Components of Diesel Power Station & their operation:-

In addition to diesel generator set or DG set there are many other auxiliaries attached to at diesel power station.

(i) Fuel supply system:- In fuel supply sys there are one storage tank strainers, fuel transfer pump & all day fuel tank. storage tank where oil is stored.

(ii) Strainer:- This oil then pump to dry tank, by means of transfer pump. During transferring from main tank to smaller dry tank, the oil passes through strainer to remove solid impurities. From dry tank the oil is injected in the diesel engine by means of fuel injection pump.

(iii) Air intake system:- This system supplies necessary air to the engine for fuel combustion. It consists of a pipe for supplying of fresh air to the engine. Filters are provided to remove dust particles from air bcoz these particles can act as an abrasive in the engine cylinder.

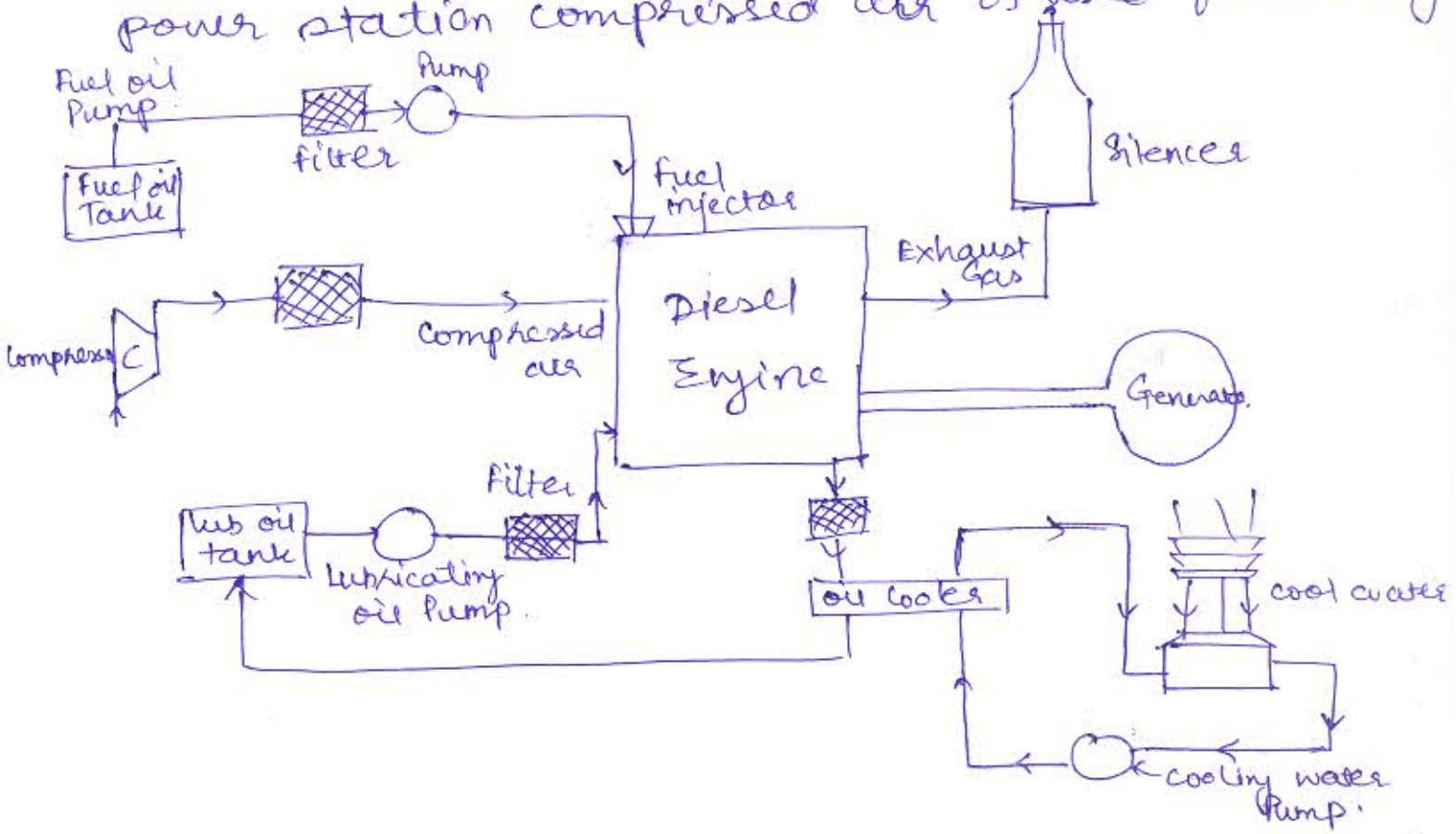
(iv) Exhaust System:- The exhaust gas is removed from engine, to the atmosphere by means of an exhaust system. A silencer is normally used in this system to reduce noise level of the engine.

(v) Cooling system:- The heat produced due to internal combustion, drives the engine. But some parts of this heat raise the temperature of different parts of the engine. High temperature may cause permanent damage to the machine.

(vi) Lubricating System:- This system minimises the wear of rubbing surface of the engine. Here lubricating oil is stored in main lubricating oil tank. This lubricating oil is drawn from the tank by means of oil pump.

Then the oil is passed through the oil filter for removing impurities from the filtering point, this clean lubricating oil is delivered to the different points of the m/c where lubrication is required.

(vii) Engine Starting System :- For starting a diesel engine, initial rotation of the engine shaft is required. Until the firing start and the unit runs with its own power for small DG set, the initial rotation of the shaft is provided by handles but for large diesel power station compressed air is used for starting.



⇒ Application of Diesel Power Station :-

Diesel power plants are also popularly used as standby supply of different industries, commercial complexes, hospitals etc. During power cut, these diesel power generators are run to fulfil required demand.

⇒ Advantages of Diesel Power Station:-

- This is simple in design point of view.
- Required very small space.
- It can also be designed for portable use.
- Initial cost is less than other types of power station.
- Thermal η of diesel is quite higher than of coal.

⇒ Disadvantages of Diesel Power Station:-

- The cost of diesel is very high compared to coal. Hence the running cost of this plant is higher compared to steam & hydro power plants.
- The plant generally used to produce small power requirement.
- Cost of lubricants is high.
- Maintenance is quite complex & costs high.
- Plant does not work satisfactorily under overload conditions for a longer period.

Ques 12(a) A steam station has two units of 110MW. The cost data is as under

Specification	Unit - I	Unit II
1. Unit Capital Cost (UC)	Rs 18000 per kw	Rs 30000 per kw
2. Fixed Charge Rate (FCR)	10%	10%.
3. Capacity factor (CF)	0.55	0.60
4. Fuel Consumption	0.7 kg/kwh	0.65 kg/kwh
5. Fuel Cost	Rs 150 per 1000 kg	Rs 150 per 1000 kg.
6. Annual Cost of Operating labour, Maintenance & Supplies (OM)	20% of Annual fuel cost	15% of annual fuel cost.
7. Utilisation factor (UF)	1	1

Calculate

(i) Annual Plant cost & generation cost of unit I

(ii) Annual Plant cost & generation cost of unit II

(iii) Overall Generation cost of the Station.

Ans (i) UNIT - I

$AFC_1 = FCR_1 \times UC_1 \times C_1 = 10 \times 18000 \times 110 \times 10^3 = Rs\ 198 \times 10^6$

$E_1 = 8760 \times CF_1 \times C_1 \times 10^3 = 52998 \times 10^4$ kWh

Annual fuel Consumption of Unit 1 $= 52998 \times 10^4 \times 0.7 = 37098.6 \times 10^4$ kg

$FC_1 = 37098.6 \times 10^4 \times 1500/1000 = Rs\ 556479 \times 10^3$

$OM_1 = 20\%\ FC_1 = 0.2 \times 556479 \times 10^3 = Rs\ 111295.8 \times 10^3$

$AOC_1 = FC_1 + OM_1 = Rs\ 66774.8 \times 10^3$

$APC_1 = AFC_1 + AOC_1 = Rs\ 865.7748 \times 10^6$

$GC_1 = APC_1 / E_1 = 1.6336$ Rs / kWh.

(ii) UNIT - II

$AFC_2 = FCR_2 \times UC_2 \times C_2 = 0.1 \times 30000 \times 110 \times 10^3 = Rs\ 330 \times 10^6$

$E_2 = 8760 \times CF_2 \times C_2 \times 10^3 = 8760 \times 0.6 \times 110 \times 10^3 = 57816 \times 10^4$ kWh

Annual fuel Consumption of Unit 2 $= 57816 \times 10^4 \times 0.65 = 375804 \times 10^5$ kg.

$FC_2 = 375804 \times 10^3 \times 1500/1000 = Rs\ 563706 \times 10^3$

$OM_2 = 15\%$ of $FC_2 = 0.15 \times 563706 \times 10^3 = Rs\ 84555.9 \times 10^3$

$AOC_2 = FC_2 + OM_2 = Rs\ 648261.9 \times 10^3$

$APC_2 = AFC_2 + AOC_2 = Rs\ 978261.9 \times 10^6$

$GC_2 = APC_2 / E_2 = 1.692$ Rs / kWh.

(iii) Overall Generation Cost.

$OGC = [(APC_1 + APC_2) / (E_1 + E_2)] = 1.664$ Rs / kWh.