MODEL TEST PAPER FOR AMIE EXAMS
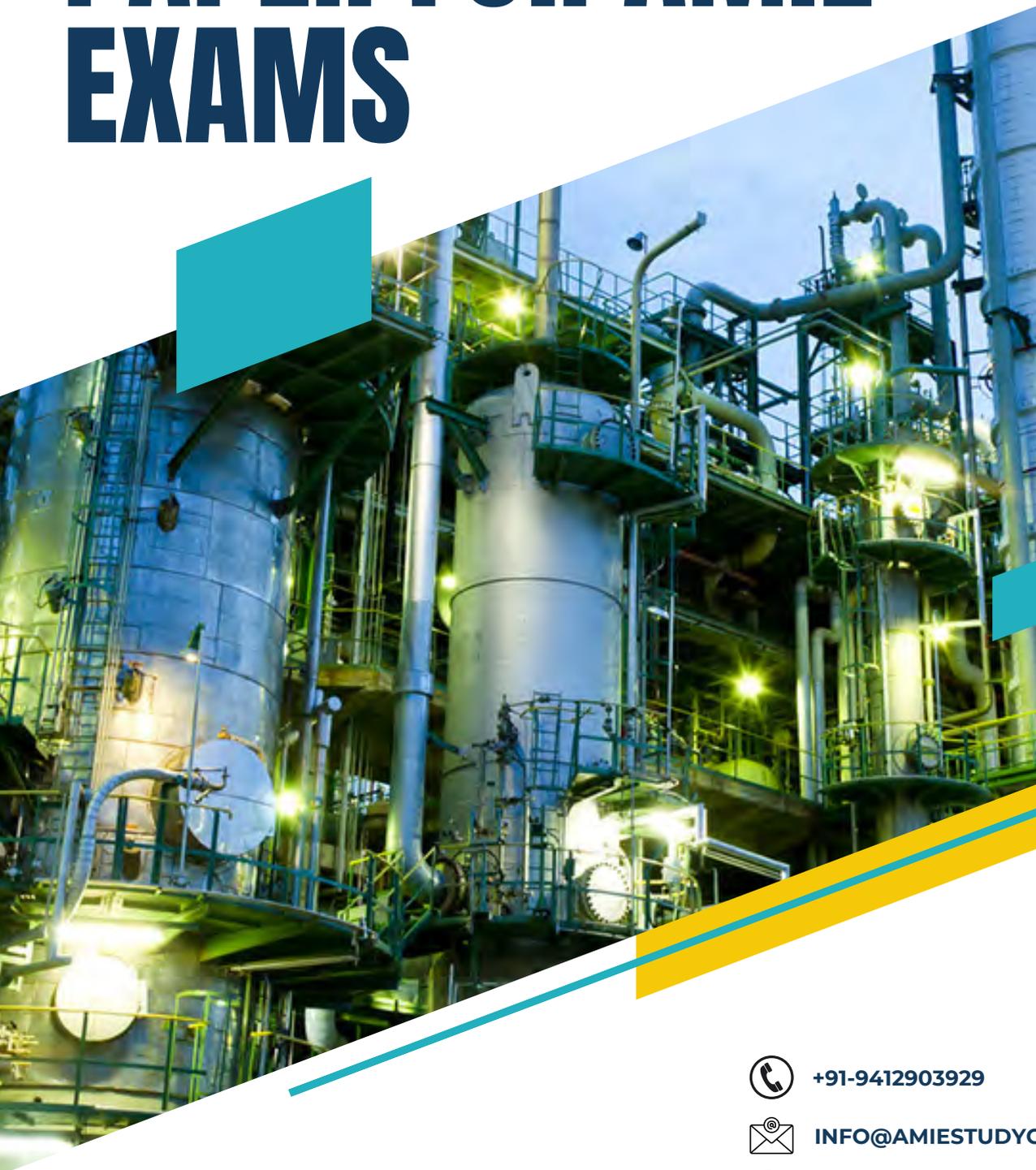
POWER PLANT ENGINEERING

TEST PAPER 1

POWER PLANT ENGINEERING

Time: *Three Hours*

Maximum Marks: *100*

Answer five questions, taking ANY TWO from Group A, any two from Group B and all from Group C.

All parts of a question (a, b, etc.) should be answered at one place.

Answer should be brief and to-the-point and be supplemented with neat sketches.
Unnecessary long answer may result in loss of marks.

Any missing or wrong data may be assumed suitably giving proper justification.

Figures on the right-hand side margin indicate full marks.

Group A

1. (a) What are the advantages of pulverised coal firing? What are different types   8
        of pulverised coal burners? Distinguish between straight flow and vortex
        burners.

    (b) What is meant by overfeed and underfeed principles of coal firing? Which is   6
        preferred for high volatile coal and why?

    (c) Find the expression of fan power and compare the powers required for FD   6
        fan and ID fan, if the air supplied is same in both cases.

2. (a) A forced draught fan supplies air at 9 m/s against a draught of 20 mm of   8
        water across the fuel bed. Calculate the power required to run the fan if 2450
        kg/h of coal is consumed and 15.5 kg of air is supplied per kg of coal burnt.
        Temperature of ambient air is 30^0C and that of flue gas is 300^0C, if the
        forced draught fan is replaced by an induced draught fan, what will be the
        power required to drive the fan.

    (b) Draw a neat sketch of a Benson boiler and label its parts mentioning its   6
        merits and demerits.

    (c) What is the difference between natural circulation and forced circulation in a   6
        water tube boiler? Why and when are downcomers placed outside the
        furnace?

3.   (a)   A steam generator comprises a boiler, a superheater, an economiser, and an   8
           air preheater. The feedwater enters the economiser at 140^0C and leaves as
           saturated liquid. Air is preheated from 25^0C to 250^0C. Steam leaves the
           boiler drum at 60 bar, 0.98 dry and leaves the superheater at 450^0C. When
           using coal with a calorific value of 25.2 MJ/kg, the rate of evaporation is 8.5
           kg steam per kg coal and the air fuel ratio is 15:1 by mass. Neglecting heat
           losses and pressure drops, estimate the heat transfer per kg fuel in each
           component and the efficiency of the steam generator. What are the
           percentages of the total heat absorption taking place in economiser, boiler
           and the superheater, respectively? Take C_p of air as 1.005 and of water as
           4.2 kJ/kgK.

     (b)   Explain the methods of energy efficiency improvements in open cycle gas   6
           turbine power plant.

     (c)   What are the advantages and disadvantages of closed cycle gas turbine   6
           power plant.

4.   (a)   A gas turbine power plant, operating on an ideal Brayton cycle, has a   8
           pressure ratio of 8. The gas temperature is 300 K at the compressor inlet and
           1300 K at the turbine inlet. Utilising the air standard assumptions, calculate
           the gas temperature at the exit of the compressor and the turbine and thermal
           efficiency. If the compressor efficiency is 80% and turbine efficiency 85%,
           determine the thermal efficiency and turbine exit temperature.

     (b)   In a gas turbine plant, compression is carried out in two stages with perfect   6
           intercooling and expansion in one stage turbine. If maximum and minimum
           temperature in the cycle remain constant, show that for maximum specific
           output of the plant, the optimum overall pressure ratio is given by

$$r_{opt} = \left[\eta_c \eta_T \frac{T_{max}}{T_{min}} \right]^{2\gamma/[3(\gamma-1)]}$$

     (c)   Describe the schematic arrangement for a diesel power plant with diagram   6
           in detail.

Group B

5.   (a)   Explain with a neat sketch, a pumped storage plant. What are its   8
           advantages? Explain its working as a peak load plant.

     (b)   Discuss the factors which should be considered while selecting a site for a   6

hydroelectric power plant.

(c) Explain what do you understand by base load and peaking load. Why are base load plants loaded heavily?   6

6. (a) Explain the factors to be considered in selection of hydraulic turbine. Differentiate between Francis and Pelton turbine. Explain the various cost components of a hydraulic project.   6

(b) A hydroelectric station operates at a head of 50 m. The catchment area of reservoir is 500 km^2. The average rainfall is 1000 mm. 25% of the rainfall is lost on account of evaporation. Loss of head in penstock is 20%. Efficiency of turbine is 80% and generator is 90%. Calculate the capacity of the plant.   8

(c) Explain the function of a moderator. What is the criterion of its effectiveness? Name a few moderators.   6

7. (a) Draw the line diagram of a power transformer and explain how it works.   8

(b) Why is generator cooling necessary? Explain the advantages and disadvantages of open system when air is used as a coolant.   6

(c) Draw a line diagram of induction type relay and explain its working.   6

8. (a) Explain various components required for a solar PV plant.   6

(b) Explain briefly the construction and operation of a solar cell.   8

(c) What are the factors to be considered in the selection and location/site of a wind mill?   6

Group C

9. Answer the following in brief: 20

   (i) Load factor of a power plant is defined as

      (a) Average load/Maximum demand

      (b) Maximum demand/Average load

      (c) Maximum demand x efficiency/average load

      (d) Maximum demand x average load.

  (ii) Economiser is used to heat

(a) feed water

(b) steam

(c) air

(d) Flue gases.

(iii)   The boiling water reactor uses

(a) plutonium

(b) enriched uranium

(c) thorium

(d) All of the above.

(iv)   Mechanical efficiency of a diesel engine Is

(a) I.H.P./B.H.P.

(b) B.H.P./I.H.P.

(c) B.H.P./F.P.

(d) B.H.P/I.H.P.

(v)   Francis turbine is used for

(a) low heads

(b) medium heads

(c) high heads

(d) very high heads.

(vi)   For maximum discharge of steam through a convergent-divergent nozzle, when steam is initially superheated, the ratio of throat to initial steam pressure is

(a) 0.62

(b) 0.578

(c) 0.546

(d) 0.45

(vii)   Hydrogen gas is used for cooling large electric generators because hydrogen

(a) is the lightest gas.

(b) has the highest specific heat.

(c) has the largest heat transfer coefficient.

(d) has the highest Prandtl number.

(viii)   The optimum reheat pressure for most of the modern steam power plants

divided by the initial steam pressure is equal to

(a) 0.2 to 0.25

(b) 0.3 to 0.35

(c) 0.4 to 0.45

(d) 0.5 to 0.55

(ix)   The temperature difference between water at the surface and lower level of ocean for few hundred meter is

(a) 20 °C

(b) 40 °C

(c) 50 °C

(d) 60 °C

(x)   The temperature of the combustion gas at the inlet to gas turbine is

(a) 715 ^{0}C

(b) 900 °C

(c) 1200 ^{0}C

(d) 1300 °C

(Refer our course material for answers)