(Set-L)

B.Tech-7th
Power Plant Engineering

Full Marks : 70

Time : 3 hours

Answer **six** questions including **Q. No. 1** which is compulsory

The figures in the right-hand margin indicate marks

Steam tables, Mollier chart may be allowed

1. Answer the following questions : 2×10

(*i*) What are the advantages of gaseous fuels ?

(*ii*) How are dust collectors classified ?

(*iii*) Why a steam condenser is used in a steam power plant ?

(*iv*) What is a cooling tower ? How are cooling towers classified ?

(*v*) State the advantages of regenerative cycle over simple Rankine cycle.

(*vi*) What do you understand by (*a*) critical pressure ratio, (*b*) choked flow ?

(*vii*) How is degree of reaction defined ? What is a 50% reaction turbine ?

(*viii*) Discuss the utility of control rods in nuclear reactor.

(*ix*) What do you mean by depreciation ?

(*x*) What do you mean by 'thermal pollution' ?

2. (*a*) Give the lay-out of a modern steam power plant and explain its working principle in brief. 5

(*b*) A steam power plant uses steam as working fluid and operates at a boiler pressure of 5 MPa, dry saturated and a condenser pressure of 5 KPa. Determine the cycle efficiency for (*i*) Carnot cycle (*b*) Rankine cycle. Also show the *T-s* representation for both the cycles. 5

3. (*a*) Explain briefly the following boiler accessories : 5

(*i*) Air preheater and (*ii*) Superheater.

(*b*) In a regenerative Rankine cycle steam enters the turbine at 200 bar, 650° C and leaves at 0·05 bar. The steam power plant makes use of a single open feed water heater working at 8 bar. Determine the thermal efficiency and steam rate of the plant. Draw the flow diagram and give the *T-s* representation for the above mentioned steam power plant. 5

4. (*a*) Show that the maximum discharge of steam through a nozzle takes place when the ratio of steam pressure at the throat to the inlet pressure is given by

$$\frac{p_2}{p_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}},$$

where n is the index of expansion. 5

(*b*) The inlet conditions of steam to a convergent-divergent nozzle is 22 bar and 260° C. The exit pressure is 4 bar. Assuming frictionless flow upto throat and a nozzle efficiency of 85%, determine : 5

(*i*) The flow rate of steam for a throat area of 32·2 cm^2

(*ii*) The exit area.

5. (*a*) What is a turbine ? How steam turbines are classified ? Explain the difference, in short between an impulse turbine and a reaction turbine. 5

(*b*) Steam issues from the nozzle of a single impulse wheel turbine at 800 m/sec. The nozzle angle is 20° and the blade angles are 30° at inlet and outlet. Determine the blade velocity and the work done per kg. of steam. Neglect the effect of friction. 5

6. (*a*) Explain the role of and reflector in nuclear reactors. Name the materials they are made of. 4

(*b*) What is a 'Liquid Metal Reactor' ? Explain briefly a typical liquid metal cooled reactor with its advantages and disadvantages. 6

7. (*a*) Explain briefly the following : 5

(*i*) Capital or fixed cost.

(*ii*) Operational cost.

(*b*) A power plant of 200 MW installed capacity has the following particulars : Capital cost = Rs. 20,000 kW installed ; Interest and depreciation = 12%, Annual load factor = 58% ; Annual capacity factor = 52%; Annual running charges = Rs. 200×10^6 ; Energy consumed by power plant auxiliaries = 5%. Calculate the cost of power generation per kWh. 5

8. (*a*) What is an electrostatic precipitator ? Explain its working with a neat sketch. 5

(*b*) What are important gaseous pollutants discharged by thermal power plants ? How are they controlled ? 5