

(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.

(Turn Over)

- (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 cm²
- (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 moderator 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
