

**POWER PLANT ENGINEERING
(MEC3144)**

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

USE OF STEAM TABLE IS PERMITTED

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Which processes do the Rankine cycle contain?
(a) Two isothermal and two isochoric processes
(b) Two isentropic and two isobaric processes
(c) Two isentropic and two isothermal processes
(d) Two isothermal and two isobaric processes.
- (ii) The ideal Rankine cycle, modified to take into account the effect of bleeding, is known as
(a) Regenerative cycle (b) Reheat cycle
(c) Saturated cycle (d) Superheat cycle
- (iii) Which of the following components is considered a boiler mounting?
(a) Economizer (b) Superheater (c) Pressure gauge (d) Air preheater
- (iv) The term priming in a boiler associated with
(a) Removal of air from the boiler shell
(b) Removal of water particles being carried by steam
(c) Firing of boilers
(d) Control of the rate of fuel consumption
- (v) In an impulse reaction turbine, the heat drops in the fixed and moving blades are 15 kJ/kg and 30 kJ/kg respectively. The degree of reaction for this stage will be
(a) 1/3 (b) 1/2 (c) 2/3 (d) 3/4
- (vi) In a reaction turbine when the degree of reaction is zero, then there is _____
(a) No heat drop in moving blades (b) Maximum heat drop in fixed blades
(c) No heat drop in fixed blades (d) Maximum heat drop in moving blades
- (vii) Which of the following terms is not related to nuclear power plants?
(a) Control Rod (b) Electrostatic precipitator
(c) Nuclear Reactor (d) Moderator.

- (viii) What is the difference between the temperature of entering and leaving water in the cooling tower?
 (a) Wet-bulb temperature (b) Dry bulb temperature
 (c) Approach (d) Range
- (ix) Sub-atmospheric pressure is also called ____
 (a) Gauge pressure (b) Absolute pressure
 (c) Vacuum pressure (d) High altitude pressure
- (x) Condensation of steam takes place at:
 (a) Constant temperature and pressure (b) Constant volume
 (c) Increasing temperature (d) Decreasing pressure

Fill in the blanks with the correct word

- (xi) In a fire tube boiler, the water to be heated is kept in the ____.
- (xii) The efficiency of a regenerative steam cycle increases when the number of extraction are ____.
- (xiii) The pressure difference that helps in supplying air and removing flue gases in a boiler is called ____.
- (xiv) In a cooling tower 'approach' is the temperature difference between: ____.
- (xv) Load duration curve indicates ____.

Group - B

2. (a) In a reheat cycle, the initial steam pressure and the maximum temperature are 150 bar and 550°C respectively. If the condenser pressure is 0.1 bar and the moisture at the condenser inlet is 12%, and assuming ideal processes, determine (i) the reheat pressure, (ii) the cycle efficiency, and (iii) the steam rate.
[[CO4) (Apply/IOCQ)]
- (b) Draw the T-s and $h - s$ diagram of Rankine cycle.
[[CO1) (Understand/LOCQ)]
- 8 + 4 = 12**
3. (a) Define steam rate and heat rate in the context of a steam power plant.
[[CO1) (Remember/LOCQ)]
- (b) In a thermal power plant operates on Rankine cycle, superheated steam is produced at 1.5 Mps and 300°C and fed to the turbine where it is expanded to a condenser pressure of 80 kPa. The saturated liquid is coming out of the condenser and back to boiler through pump. Assuming ideal process determine (i) The condition of steam after isentropic expansion (ii) Rankine cycle efficiency. (iii) Ideal steam consumption per kWh.
[[CO4) (Apply/IOCQ)]
- 2 + 10 = 12**

Group - C

4. (a) Define the following: (i) Equivalent evaporation, (ii) Factor of evaporation, (iii) Boiler efficiency.
[[CO2) (Discuss/IOCQ)]

- (b) Calculate the quantity of air supplied per kg of fuel burnt in the combustion chamber of a boiler when the required draught of 1.85 cm of water is produced by a chimney of 32 m height. The temperatures of the flue gases and ambient air recorded are 370°C and 30°C respectively. [[CO2] (Apply/LOCQ)]
4 + 8 = 12
5. (a) What is meant by 'equivalent evaporation' in a boiler? How is 'equivalent evaporation' calculated in a boiler? [[CO2] (Understand/IOCQ)]
- (b) What is meant by 'boiler efficiency'? What is the typical range of boiler efficiency in modern power plants? [[CO2] (Understand/IOCQ)]
- (c) What is the formula for calculating boiler efficiency using the 'direct method'? What are the main factors that affect boiler efficiency? [[CO2] (Understand/IOCQ)]
4 + 4 + 4 = 12

Group - D

6. (a) In a stage of an impulse turbine provided with a single row wheel, the mean diameter of the blade ring is 800 mm and the speed of rotation is 3000 rpm. The steam issues from the nozzles with a velocity of 300 m/s and the nozzle angle is 20°. The rotor blades are equiangular and the blade friction factor is 0.86. What is the power developed in the blading when the axial thrust on the blades is 140 N? [[CO3] (Apply/IOCQ)]
- (b) Explain the following term with respect to nozzle flow (i) Choked flow and (ii) Super saturated flow. [[CO3] (Remember/LOCQ)]
8 + 4 = 12
7. (a) Steam is expand in a set of nozzle from 10 bar 300 ° C to 2 bar. Are the nozzles convergent or convergent – divergent? Neglecting the initial velocity, find the minimum area of the nozzles to flow 1kg/s of steam. Assume isentropic expansion. Draw the suitable T-s diagram to illustrate the process. [[CO3] (Solve/IOCQ)]
- (b) Explain the following term with respect to nozzle flow (i) Critical pressure ratio and (ii) Stagnation pressure and temperature. [[CO3] (Solve/IOCQ)]
6 + 6 = 12

Group - E

8. (a) The peak load on a power plant is 60 MW. The loads having maximum demands of 30 MW, 20 MW, 10 MW, and 15 MW are connected to the power plant. The capacity of the power plant is 80 MW and the annual load factor is 0.55. Estimate (i) the average load on the power plant, (ii) the energy supplied per year, (iii) the demand factor (iv) the diversity factor. [[CO6] (Evaluate/HOCQ)]
- (b) Write a short note on Pressurized Water Reactor (PWR). [[CO3] (Remember/LOCQ)]
6 + 6 = 12
9. (a) Describe the advantages and disadvantages of hydroelectric power plant. [[CO3] (Apply/IOCQ)]

- (b) Steam enters the condenser at 35.5°C. The condenser vacuum is 70 cm of mercury when the barometer reads 75.5 cm of Hg. Determine the vacuum efficiency. Estimate the mass of air present in the condenser per kg of steam.

[[CO4) (Apply/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25	68.75	6.25