CBCS SCHEME

USN | | | | | | | | | | |

21MR34

Third Semester B.E. Degree Examination, June/July 2023
Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. *Answer any FIVE full questions, choosing ONE full question from each module.*
2. *Assume any missing data suitably.*

Module-1

1 a. Derive an expression for p-dv work in the following quasi-static processes.
i) Isothermal process ii) Polytropic process. Also draw a P.V diagram for a polytropic process when n = 0, 1, 2 and ∞ starting from a single point. **(10 Marks)**

b. A cylinder contains 1Kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly. Behind a piston according to the law PV^2 = constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position. Heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bars. Calculate the net work done by the fluid, for an initial volume of $0.05m^3$. **(10 Marks)**

OR

2 a. Derive steady flow energy equation (SFEE) in the usual form extend SFEE and modify it to i) a turbine ii) a boiler. **(10 Marks)**

b. A fluid system undergoes a non-flow frictionless process following the pressure volume relation as $P = \frac{5}{V} + 1.5$ where P is in bar and V is in m^3. During the process the volume changes from $0.15m^3$ to $0.05m^3$ and the system rejects 45kJ of heat. Determine the change in internal energy. **(10 Marks)**

Module-2

3 a. Give the Kelvin-Planck and Clausius statement of second law of thermodynamics. Prove their equivalences. **(10 Marks)**

b. A reversible heat engine operates between two reservoirs at temperatures 700°C and 50°C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 50°C and -25°C. The heat transfer to the engine is 2500kJ and the network output of the combined engine refrigerator plant is 400kJ i) Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C. **(10 Marks)**

OR

4 a. Prove that the change of entropy in an irreversible process is given by : $S_a - S_1 \geq \int_1^2 \frac{dQ}{T}$. **(08 Marks)**

b. Entropy of the universe is increasing. Justify. **(04 Marks)**

c. One Kg of ice at -5°C is exposed to the atmosphere which is at 20°C. The ice melts and comes into thermal equilibrium with the atmosphere. Determine the entropy increase of the universe. Take $C_{P_{ice}} = 2.093kJ/KgK$, $C_{P_{water}} = 4.187kJ/KgK$ latent neat of fusion 333.3kJ/Kg. **(08 Marks)**

Module-3

5 a. Explain the following : i) compressibility factor ii) compressibility chart. **(06 Marks)**

b. Derive Clausius-Claperyon equation for evaporation of liquids. **(06 Marks)**

c. Derive the Maxwell's equations for a pure substance. **(08 Marks)**

OR

6 a. Define the following : i) Entropy of formation ii) Adiabatic flame temperature iii) Theoretical air iv) Excess air. **(08 Marks)**

b. Methane (CH_4) is burned with atmospheric air. The analysis of the products on a dry basis is as follows : $CO_2 = 10\%$ $O_2 = 2.37\%$, $CO = 0.53\%$, $N_2 = 87.10\%$
i) Determine the combustion equation ii) Percent theoretical air. **(12 Marks)**

Module-4

7 a. Explain the working of separating and throttling calorimeter with a neat block diagram and L-S diagrams. Also define the quality of steam. **(10 Marks)**

b. A vessel of volume $0.04m^3$ contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9Kg. Find the pressure, the mass the specific volume, the enthalpy, the entropy and the internal energy. **(10 Marks)**

OR

8 a. Explain the working of a regenerative vapor power cycle with two closed feed water heaters with neat block diagram. Also write T-S diagram for it. **(10 Marks)**

b. Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser when it is condensed to saturated liquid water. The pump feeds back into the boiler. i) Assuming ideal process, find per Kg of steam network an cycle efficiency ii) If turbine and pump have each an 80% efficiency, find percentage reduction in network and cycle efficiency. **(10 Marks)**

Module-5

9 a. Derive an expression for the air-standard efficiency of a Diesel cycle. **(08 Marks)**

b. An air standard Dual cycle has a compression ratio of 16 and compression begins at 1 bar 50°C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate :
i) Pressure and temperature at the cardinal points of the cycle
ii) the cycle efficiency
iii) m.e.p of the cycle.
Take q = 0.718kJ/Kg K, $C_p = 1.005$kJ/Kg K. **(12 Marks)**

OR

10 a. Explain the effect of regeneration on Brayton cycle efficiency. **(06 Marks)**

b. Explain the working of a turbojet engine with a neat block diagram. **(06 Marks)**

c. In a gas turbine plant, working on the Brayton cycle with a regenerator of 75% effectiveness, the air at the inlet to the compressor is at 0.1MPa, 30°C the pressure ratio is 6 and the maximum cycle temperature is 900°C. If the turbines and compressor have each an efficiency of 80% find the percentage increase in the cycle efficiency due to generation. **(08 Marks)**

* * * * *