UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: B.Tech. (APE – Up, GSE, GIE, ET+LLB) | **Semester – III**
Subject (Course): Thermodynamics and Heat Engines | **Max. Marks : 100**
Course Code : GNEG241 | **Duration : 3 Hrs**
No. of page/s: 2

Note: Attempt all the questions of a section at one place. All questions are compulsory. State your assumptions clearly.

Section – A (4 x 5 = 20 Marks)

1. What is entropy principle? Why does entropy of the universe keep on increasing?

2. Show how violation of Clausius' statement leads to violation of Kelvin Planck's statement of II law of thermodynamics.

3. State and prove Carnot's theorem.

4. What do you understand by cubic equation of state? What does the roots of a cubic equation signify?

Section – B (5 x 8 = 40 Marks)

5. A mass of air is initially at 260^0C and 700 kPa, and occupies 0.028 m^3. The air is expanded at constant pressure to 0.084 m^3. A polytropic process with n=1.5 is then carried out, followed by a constant temperature process which completes the cycle. All the processes are reversible. Sketch the cycle in p-v and T-s planes. Find the heat received and heat rejected in the cycle.

6. The air speed of a turbojet engine in flight is 270 m/s. Ambient air temperature is -15^0C. Gas temperature at outlet of nozzle is 600^0C. Corresponding enthalpy values for air and gas are 260 and 912 kJ/kg respectively. Fuel-air ratio is 0.019. Chemical energy of the fuel is 44.5 MJ/kg. Owing to incomplete combustion, 5% of the chemical energy is not released in the reaction. Heat loss from the engine is 21 kJ/kg of air. Calculate the velocity of the exhaust jet.

7. Two reversible heat engines A and B are arranged in series between two thermal reservoirs maintained at 1000 K and 100 K respectively. Engine 'A' receives 1680 kJ of heat from 1000 K reservoir and rejects heat directly to 'B'. If both the engines have equal thermal

efficiencies, determine (a) the intermediate temperature between A and B, (b) work done by both the engines and (c) heat rejected by engine 'B'.

8. Derive an expression for the maximum work that can be obtainable from two finite bodies which are at temperatures T_1 and T_2 ($T_1 > T_2$), using entropy principle.

9. A mass of 0.25 kg of an ideal gas is at 300 kPa and 80^0C occupying 0.07 m^3. The gas undergoes an irreversible adiabatic process to a final pressure of 300 kPa and final volume of 0.1 m^3, during which the work done on the gas is 25 kJ. Evaluate the increase in entropy of the gas.

Section – C (2 x 20 = 40 Marks)

10. Boiler steam at 8 bar, 250^0C, reaches the engine control valve through a pipeline at 7 bar, 200^0C. It is throttled to 5 bar before expanding in the engine to 0.1 bar, 0.9 dry. Determine per kg of steam (a) the heat loss in the pipeline, (b) the temperature drop in passing through the throttle valve, (c) the work output of the engine, (d) the entropy change due to throttling and (e) entropy change in passing through the engine.

11. In an air standard Otto cycle, the compression ratio is 7. Compression begins at 0.1 MPa, 35^0C. The maximum temperature of the cycle is 1100^0C. Find (a) the pressure and temperature at cardinal points of the cycle (b) the heat supplied per kg of air, (c) the cycle efficiency and (e) the mean effective pressure of the cycle.

Or

Describe Diesel cycle in detail and derive an expression for the efficiency of a Diesel cycle. Also explain which cycle is most efficient among Otto and Diesel cycles for same compression ratio and heat rejection.