[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. …….

Program: B. Tech.

Semester: 3rd

Name of Subject: Thermodynamics

Subject Code: PCME-101

Paper ID: 16072

Time Allowed: 02 Hours **Max. Marks: 60**

23-07-21(E)

NOTE:

1. Each question is of 10 marks.
2. Attempt any six questions out of nine.
3. Any missing data may be assumed appropriately.
4. Use of steam table is allowed.

Q1. 0.5 kg of air is compressed reversibly and adiabatically from 80kPa and 60°C to 0.4 MPa and is then expanded at constant pressure to the original volume. Sketch the process on p-V and T-S diagrams, compute work transfer, heat transfer and change in entropy for whole path. Take R = 0.287 kJ/kg.K and $\gamma = 1.4$.

Q2. State and prove that Kelvin Plank and Clausius's statements of second law of thermodynamics are equivalent to each other.

Q3. In an SI engine working on the ideal Otto cycle, the compression ratio is 5.5. The pressure and temperature at the beginning of compression are 1 bar and 27°C, respectively. The peak pressure is 30 bar. Determine the pressure, temperature at the salient points, the air standard efficiency, and mean effective pressure. Assume ratio of specific heat to be 1.4 for air.

Q4. Explain the working of two stroke petrol engine in detail with neat sketch.

Q5. A sample of dry anthracite has the following composition by mass:
C=90% H=3% O_2=2.5% N=1% S=0.5% ash=3%
Calculate:

i) Stoichiometric air-fuel ratio,
ii) The actual air-fuel ratio and
iii) Dry and wet analysis of products of combustion by mass and by volume when 20% excess air is supplied.

Q6. A steam power plant operates on a theoretical reheat cycle. The steam from boiler at 150 bar and 550°C expands through the high-pressure turbine. It is reheated at constant pressure of 40 bar to 550°C and expands through the low pressure turbine to a condenser pressure of 0.1 bar. Draw T-s diagrams and find:

i) Quality of steam at turbine exhaust,
ii) Thermal efficiency of the cycle,
iii) Steam rate in kg/kWh.

Q7. At the inlet to a convergent-divergent nozzle the enthalpy of the fluid passing is 3000kJ/kg and the velocity is 60m/s. At the discharge end, the enthalpy is 2757kJ/kg. The nozzle is horizontal and the heat loss during flow is negligible. Find (a) velocity of the fluid at the exit of the nozzle, (b) if the inlet area is 0.1 m^2 and the specific volume at the inlet is 0.187m^3/kg, find the mass flow rate of the fluid, and (c) if the specific volume at the outlet is 0.498m^3/kg, find the area at the exit of the nozzle.

Q8. Drive an expression to find the thermal efficiency and mean effective pressure of air standard diesel cycle. Draw p-v and T-s diagrams of diesel cycle.

Q9. A Carnot heat engine receives heat at 750K and rejects waste heat to the environment at 300K. The entire work output of the heat engine is used to drive a Carnot refrigerator which removes heat from the cooled space at -15°C at the rate of 400kJ/min and rejects it to the same environment at 300K. Determine:

i) The rate of heat supplied to the heat engine; and
ii) The total rate of heat rejection to the environment.

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