EVENING

0 8 MAR 2021

Please check that this question paper contains 09 questions and 02 printed pages within first ten minutes.

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

Uni. Roll No. .....

Program/ Course: B. Tech. **(Batch 2018 onward)**
Semester: **3rd**
Name of Subject: **Thermodynamics**
Subject Code: **PCME-101**
Paper ID:. 16072

Time Allowed: 03hrs **Max. Marks: 60**

Note:

1. **Section-A**and **Section-B** are compulsory.
2. **Section-C** has Two Questions **Q8** and **Q9**. Both are compulsory, but with internal choice.
3. Any missing data may be assumed appropriately.
4. Use of **steam table** is allowed.

Section – A **[Marks: 02 each]**

Q1.

a) What is an enthalpy?

b) Air enters a convergent nozzle with a velocity of 40m/s. The enthalpy of air decreases by 180kJ/kg. Determine the exit velocity. Assume adiabatic conditions in the nozzle.

c) How quality of steam can be determined?

d) What is cut off ratio?

e) Define degree of superheatfor steam.

f) What are the similarities between work and heat?

Section – B **[Marks: 04 each]**

Q2. 1.5 kg of Nitrogen contained in a cylinder at pressure 6 bar and temperature 300K expands three times its original volume. Assuming the expansion process to be isobaric, make calculations for: (i) Final volume, (ii) Work done by gas, (iii) head added, and (iv) change in internal energy. For Nitrogen: c_p=1.05kJ/kgK and R = 295J/kgK.

Q3. What is Clausius inequality? Prove that for any engine $\oint \frac{\partial Q}{T} \leq 0$.

Q4. A reversible heat engine receives heat from two thermal reservoirs maintained at constant temperature of 750K and 500K. The engine develops 100KW and rejects 3600kJ/min of heat to a heat sink at 250K. Determine thermal efficiency of the engine and heat supplied by each thermal reservoir.

P.T.O

Q5. Find the internal energy of 1kg of steam at a pressure of 10ba, when the condition of steam is;

(i) Wet with a dryness fraction of 0.85,

(ii) Dry and saturated, and

(iii) Superheated, the degree of superheat being 50°C.

The specific heat of superheat steam at constant pressure is 2.01kJ/kgK.

Q6. How Rankine cycle is effected by exhaust pressure and superheating? Draw neat TS diagram for change in each variable.

Q7. The percentage analysis of a gas by volume is given as:

$CO_2 = 5.5\%$, $CO = 38.3\%$, $CH_4 = 0.4\%$, $O_2 = 0.1\%$, $H_2 = 52.8\%$ and $N_2 = 2.9\%$.

Obtain the percentage analysis by mass.

Section – C **[Marks: 12 each]**

Q8. Explain the working principle of four stroke petrol engine and compare it with two stroke petrol engine

OR

(a) Define an adiabatic process. Show that for a reversible adiabatic process of a given mass of perfect gas: pv^{γ}=constant. **[Marks: 08]**

(b) What are the limitations of first law of thermodynamics? **[Marks: 04]**

Q9. Consider a steam power plant that operates on the ideal reheat Rankine cycle. The plant maintains the inlet of the high-pressure turbine at 4 MPa and 300°C, the inlet of the low-pressure turbine at 1.4 MPa and 300°C, and the condenser at 75 kPa.The net power produced by this plant is 5000 kW. Determine the rate of heat addition and rejection and the thermal efficiency of the cycle.

OR

3kg of air at a pressure of 150kPa and temperature 360K is compressed polytropically to 750kPa according to law $pv^{1.2}$=C. The gas is then cooled to initial temperature at constant pressure. The air is then expanded at constant temperature till it reaches original pressure of 150kPa. Draw the cycle on p-v diagram and determine the net work and heat transfer.

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