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# CS/B.TECH(AUE-OLD)/SEM-3/AUE-303/2011-12 2011

### **ENGINEERING THERMODYNAMICS**

Time Allotted: 3 Hours Full Marks: 70

The figures in the margin indicate full marks.

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

#### **GROUP - A**

### (Multiple Choice Type Questions)

- 1. Choose the correct alternatives for the following:  $10 \times 1 = 10$ 
  - i) Thermodynamic properties are
    - a) path functions
    - b) point functions
    - c) may be path or point functions
    - d) none of these.
  - ii) A heat engine is supplied heat at the rate of 30,000 J/S and gives an output of 9 kW. The thermal efficiency of the engine will be
    - a) 30%

b) 33%

c) 40%

d) 50%.

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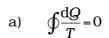
## iii) In a thermodynamic cycle



- a) complete conversion of heat into work is possible
- b) complete conversion of heat into work is impossible
- c) heat and work are completely interchangeable
- d) none of these.
- iv) Any spontaneous process is
  - a) reversible
  - b) irreversible
  - c) may be reversible or irreversible
  - d) none of these.
- v) Entropy generation of a reversible system is
  - a) positive
  - b) negative
  - c) zero
  - d) dependent on the process.







b) 
$$\oint \frac{dQ}{T} > 0$$

c) 
$$\oint \frac{\mathrm{d}Q}{T} \ge 0$$

d) 
$$\oint \frac{\mathrm{d}Q}{T} \le 0$$
.

- vii) For a mercury-steam binary cycle if the topping cycle has the efficiency 0.5 and the bottom cycle has the efficiency 0.40. What is the efficiency of the combined cycle?
  - a) 0.45

b) 0.55

c) 0.70

- d) 0.75.
- viii) The equation Tds = dH Vdp holds good for
  - a) reversible process only
  - b) irreversible process only
  - c) isentropic process only
  - d) any process.
- ix) For same maximum pressure and temperature and same heat ejection between Otto cycle and Diesel cycle
  - a) Otto cycle is more efficient
  - b) Diesel cycle is more efficient
  - c) both are equal efficient
  - d) efficiency cannot be compared.

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x) If relative humidity is 100% degree of saturation is

a) 0.5

b) 1

c) 0.75

d) 0.

### **GROUP - B**

### (Short Answer Type Questions)

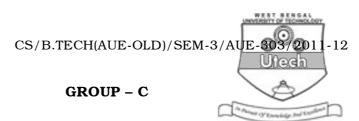
Answer any *three* of the following.

 $3 \times 5 = 15$ 

- What is enthalpy? Starting from steady flow energy equation, show that for a throttling process enthalpy of the fluid remains constant.
- 3. What is Clausius' theorem ? Show that entropy is a thermodynamic property. 2+3
- 4. Explain that *Rankine* cycle is more suitable than Carnot cycle for steam power plants.
- 5. What is one tone of refrigeration ? What is the chemical formula of refrigerant R-110 ? 3+2
- 6. What is specific humidity?

Show that  $W = 0.622 \times \frac{P_w}{P - P_w}$  where, W is specific humidity.

 $P_w$  is partial pressure of water vapour and P is the atmospheric pressure. 2+3



#### (Long Answer Type Questions)

Answer any *three* of the following.  $3 \times 15 = 45$ 

- 7. a) What are the causes of irreversibility?
  - b) Between a 1 kW electric heater and 1 kW heat pump, which one is more efficient to heat a room? Give explanation to your answer.
  - c) A domestic food freezer maintains a temperature maintains a temperature of -15°C. The ambient air temperature is 30°C. If heat leaks into the freezer at the continuous rate of 1.75 kJ/s, what is the least power necessary to pump this heat out continuously?

4 + 4 + 7

- 8. a) Show that the efficiency of Rankine cycle is a function of mean temperature of heat addition.
  - b) Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar, then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assuming ideal process find.
    - (i) Per kg of steam the net work and cycle efficiency
    - (ii) If the turbine and the pump have each 80% efficiency, find percentage reduction in the net work and cycle efficiency. 3 + (7 + 5)

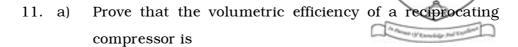


- 9. a) What is dew point temperature?
  - b) A simple R-12 plant is to develop 5 tonnes of refrigeration. The condenser and evaporator temperatures are to be 40°C and -10°C respectively. Determine:
    - (i) the refrigerant flow rate
    - (ii) the volume flow rate handled by the compressor
    - (iii) power required to drive the compressor
    - (iv) the pressure ratio
    - (v) the COP
    - (vi) heat rejected to the condenser.  $3 + (2 \times 6)$
- 10. a) Show that the efficiency of diesel cycle is

$$n_{Diesel} = 1 - \frac{1}{\gamma} \times \frac{1}{r_k^{\gamma - 1}} \times \frac{r_c^{\gamma - 1} - 1}{r_c - 1}$$

- 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) the pressure and temperature at the cardinal points of the cycle
  - (i) the cycle efficiency. 5 + (5 + 5)

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$$n_{vol} = 1 + C + C \times \left(\frac{p_2}{p_1}\right)^{\frac{1}{n}}$$

Where, C is the clearance and  $p_2$  and  $p_1$  are the discharge and suction pressures respectively.

b) A diesel engine has a compression ratio of 14 and cutoff takes place at 6% of stroke. Find the air standard efficiency. 7+8