	Conseque
Name:	
Roll No.:	70.49
Invigilator's Signature :	
CS/B.Tech(ME(N)/PE(N)/PWE(N)/A	UE(N))/SEM-3/ME-301/2011-12

2011 APPLIED 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 of the following: $10 \times 1 = 10$
 - i) A heat engine is supplied with heat at the rate of 30000 J/s and gives an output of 9 kW. The thermal efficiency of the engine will be
 - a) 33%
 - b) 30%
 - c) 45%
 - d) 29%.

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- ii) For same maximum pressure and temperature and same heat rejection for an Otto and a Diesel cycle
 - a) Otto cycle is more efficient
 - b) Diesel cycle is more efficient
 - c) both are equally efficient
 - d) efficiencies cannot be compared.
- iii) COP of a heat engine, when operating between same two temperatures that of a refrigerator, is
 - a) more than the COP of refrigerator
 - b) less than the COP of refrigerator
 - c) equal to the COP of refrigerator
 - d) none of these.
- iv) Joule-Thompson coefficient for an ideal gas, having equation of state PV = RT, is
 - a) 1

b) infinite

c) 0.5

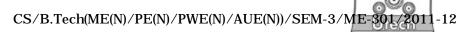
d) 0.

- v) With suction pressure and clearance unchanged, for increase in delivery pressure volumetric efficiency of a reciprocating air compressor
 - a) increases

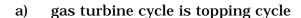
b) decreases

c) remains same

d) none of these.



vi) In a cogeneration cycle



- b) steam turbine cycle is topping cycle
- any one of gas or steam turbine cycle can act as topping cycle
- d) none of these.
- vii) Value of dryness fraction of superheated vapour is
 - a) unity

- b) greater than unity
- c) less then zero
- d) not defined.
- viii) Which one is the correct selationship?

a)
$$dh = Tds - vdp$$

b)
$$dh = Tds + vdp$$

c)
$$dh = Tds - pdv$$

d)
$$dh = Tds + pdv$$
.

- ix) When dry bulb and wet bulb temperatures of air are same, the relative humidity will be
 - a) 0%

- b) 50%
- c) 66 67%
- d) 100%.

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- x) Optimum intermediate pressure in a two stage compressor is
 - a) arithmetic mean of the suction and delivery pressure
 - b) geometric mean of the suction and delivery pressure
 - c) harmonic mean of the suction and delivery pressure
 - d) none of these.

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

- 2. Derive Maxwell's relations.
- 3. A 200 m³ rigid tank contains compressed air at 1 MPa and 330 K. Determine how much work can be obtained from this air, if the environmental conditions are 100 kPa and 300 K.
- 4. Deduce Clausius-Clapeyron's equation. Explain how the equation can be used to calculate latent heat of evaporation.

3 + 2



- 5. What is specific humidity? Show that $W = 0.622 \times \frac{p_w}{p p_w}$ where w is the specific humidity, p_w is the partial pressure of water vapour and p is the atmospheric pressure. 2 + 3
- 6. a) What do you mean by entropy generation?
 - b) Give the expression for the reversible work in a steady flow process under a given environment. 2 + 3

GROUP - C

(Long Answer Type Questions)

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

- 7. a) What do mean by engine knock? How does it originate? What is its consequence?
 - b) In an air standard Diesel cycle, the compression ratio is 16 and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0·1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C.
 - i) Find the cut-off ratio
 - ii) Find the heat supplied per kg of air
 - iii) Find the cycle efficiency
 - iv) Find the m.e.p.

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iv) cycle efficiency.

- 10
- b) i) What do you understand by the entropy principle?
 - ii) Why is the Carnot cycle on *T-S* plot a rectangle? 2
- 9. a) What is a pure substance?

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- b) What do you understand by triple point?
- c) Draw the phase equilibrium diagram for a pure
 - substance on *T*-s plot with relevant constant property lines.
- d) A vessel of volume 0.04 m³ contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy.

- 10. a) Why the gas cycle refrigeration is preferred in aircraft?
 - b) A 5 tonne R-12 plant maintains a cold store at 15°C. The refrigerant flow rate is 0·133 kg/s. The vapour leaves the evaporator with 5°C superheat. Cooling water is available in plenty in 25°C. A suction line heat exchanger subcools the refrigerant before throttling. Find (a) the compressor discharge temperature, (b) the COP, (c) the amount of sub-cooling in degree C and the dimension of compressor cylinder, if the speed is 900 rpm, stroke-to-bore ratio is 1·2 and volumetric efficiency is 95%. Allow approximately 5°C temperature difference in the evaporator and condenser.
 - c) Saturated air at 2°C is required to be supplied to a room where the temperature must be held at 20°C with a relative humidity of 50%. The air is heated and then water at 10°C is sprayed in to give the required humidity. Determine the temperature to which the air must be heated and the mass of spray water required per m ³ of air at room conditions. Assume that the total pressure is constant at 1.013 bar and neglect the fan power.
- 11. a) Prove that entropy is a property of the system.
 - b) Prove that a reversible engine gives maximum efficiency while operating between same two temperatures.8

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