USN | | | | | | | | | | |

10ME/AU43

Fourth Semester B.E. Degree Examination, December 2012
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Use of thermodynamic data book is permitted.

PART – A

1 a. Define: i) Stoichiometric air-fuel ratio ii) Enthalpy of combustion
iii) Enthalpy of formation iv) Combustion efficiency
v) Adiabatic flame temperature. **(10 Marks)**

b. A sample of fuel has the following percentage composition by weight:
Carbon = 83%, Hydrogen = 11%, Oxygen = 3%, Nitrogen = 2%, Ash = 1%
i) Determine the stoichiometric air fuel ratio by mass.
ii) If 20% excess air is supplied, find the percentage composition of dry flue gases by volume. **(10 Marks)**

2 a. Derive an expression for air-standard efficiency of limited pressure cycle. **(10 Marks)**

b. The pressures on the compression curve of a diesel engine are at $1/8^{th}$ stroke 1.4 bar and at $7/8^{th}$ stroke 14 bar. Estimate the compression ratio. Calculate the air standard efficiency and mean effective pressure of the engine if the cut-off occurs at $1/15^{th}$ of the stroke. Assume initially air is at 1 bar and 27°C. **(10 Marks)**

3 a. List out the methods used for measuring friction power of an IC engine. Explain motoring test. **(05 Marks)**

b. Explain Morse test. **(05 Marks)**

c. During a trial of 60 minutes on a single cylinder oil engine having cylinder dia 300 mm, stroke 450 mm and working on two-stroke cycle, the following observations were made:
Total fuel used = 9.6 litres
Calorific value of fuel = 45000 kJ/kg
Total number of revolutions = 12624
Gross mean effective pressure = 7.24 bar
Pumping mean effective pressure = 0.34 bar
Net load on brake = 3150 Newton
Diameter of brake drum = 1.78 m
Diameter of rope = 40 mm
Cooling water circulated = 545 litres
Cooling water temperature rise = 25°C
Specific gravity of oil = 0.8
Heat carried away by the exhaust gases = 15% total heat supplied.
Determine IP, BP and mechanical efficiency. Draw up the heat balance sheet on minute basis. **(10 Marks)**

4 a. With a schematic diagram, explain the working of reheat vapour power cycle and deduce an expression for cycle efficiency. **(10 Marks)**

b. A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410°C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle.
If the steam is reheated at 5.5 bar to a temperature of 400°C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle? **(10 Marks)**

PART – B

5 a. Show that for a multistage compressor $Z = \left(\frac{P_{x+1}}{P_1}\right)^{1/x}$ where Z = stage pressure ratio, x = number of stages, $\frac{P_{x+1}}{P_1}$ = overall pressure ratio. **(08 Marks)**

b. What are the advantages of multistage compressor? **(04 Marks)**

c. Air at standard atmospheric conditions is compressed and delivered to a receiver of 0.4 m diameter and 1 m long until a final pressure of 10 atm is reached. Assuming ideal conditions with no valve pressure drops, compute the power needed to drive the compressor for (i) isothermal compression, (ii) polytropic compression with n = 1.32.

Assume that the receiver temperature is maintained atmospheric throughout and filling takes place in 5 min. atmospheric temperature is 25°C. Also calculate isothermal efficiency of the compressor. **(08 Marks)**

6 a. With a neat block diagram and T-S diagram, explain how inter-cooling increases thermal efficiency of gas turbine plant. **(06 Marks)**

b. With a neat sketch, explain the working of Ram Jet. **(04 Marks)**

c. In a gas turbine plant working on Brayton cycle with a regenerator of 75% effectiveness, the air at the inlet to the compressor is at 0.1 MPa, 30°C, the pressure ratio is 6 and the maximum cycle temperature is 900°C. If the turbine and compressor have each an efficiency of 80%, find the percentage increase in the cycle efficiency due to regeneration. **(10 Marks)**

7 a. With a neat schematic diagram, explain the working of steam jet refrigeration. **(10 Marks)**

b. A Freon-12 refrigerator producing a cooling effect of 20 kJ/s operates on a vapour compression cycle with pressure limits of 1.509 bar and 9.607 bar. The vapour leaves the evaporator dry saturated and there is no under-cooling. Determine the power required by the machine. If the compressor operates at 300 rpm and has a clearance volume of 3% of stroke volume, determine the piston displacement of the compressor. Assume volumetric efficiency of compressor as 88%.

Properties of Freon – 12:

Temperature °C	P bar	V_g m^3/kg	h_f kJ/kg	h_g kJ/kg	s_f kJ/kgK	s_g kJ/kgK	c_p kJ/kgK
-20	1.509	0.1088	17.8	178.61	0.073	0.7082	--
40	9.607	--	74.53	203.05	0.2716	0.683	0.747

(10 Marks)

8 a. With a neat schematic diagram, explain the working of winter air conditioning system. Represent the processes on psychrometric chart. **(10 Marks)**

b. For a hall to be air conditioned, the following conditions are given:

Out door condition = 40°C DBT, 20°C WBT

Required comfort condition = 20°C DBT, 60% RH

Seating capacity of the hall = 1500

Amount of outdoor air supplied = 0.3 m^3/min/person

If the required condition is achieved first by adiabatic humidification and then by cooling, estimate: i) capacity of the cooling coil in TOR, ii) capacity of the humidifier in kg/h, iii) condition of air after adiabatic humidification. **(10 Marks)**

* * * * *