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10ME/AU43

# Fourth Semester B.E. Degree Examination, Dec.2016/Jan.2017

## 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 handbook and charts is permitted.***



### PART – A

1 a. Explain the following terms with reference to a combustion process:
i) Enthalpy of formation ii) Adiabatic flame temperature
iii) Enthalpy of combustion iv) Heat of reaction **(08 Marks)**

b. The products of combustion of an unkown hydrocarbon $C_xH_y$ have the following composition as measured by an orsat apparatus: $CO_2$ = 8.0%, CO = 0.9%, $O_2$ = 8.8%, $N_2$ = 82.3%. Determine,
i) The composition of the fuel,
ii) The air fuel ratio,
iii) The percent excess air used. **(12 Marks)**

2 a. Derive with usual notations an expression for the air standard efficiency of a diesel cycle. Represent the cycle on P-V and T-S diagrams. **(10 Marks)**

b. An engine working on the otto cycle has an air standard cycle efficiency of 56% and rejects 544 kJ/kg of air. The pressure and temperature of air at the beginning of compression are 0.1 MPa and 60°C respectively. Compute:
i) The compression ratio
ii) The work done/kg of air
iii) The pressure and temperature at the end of compression,
iv) The maximum pressure in the cycle. **(10 Marks)**

3 a. Describe Morse test. What are the assumptions made in this test? **(08 Marks)**

b. A gas engine working on constant volume cycle the following results during a one hour test run. Cylinder diameter 24 cm, stroke 48 cm, effective diameter of brake wheel 1.25 m. Net load on brake 1236 N. Average speed 226.7 revolution per minute. Average explosions per minute 77, MEP 7.5 bar, gas used 13 $m^3$ at 15°C and 771 mm of mercury pressure. Lower calorific value of gas 22000 kJ/$m^3$ at NTP. Cooling water used 625 kg. Rise in temperature of cooling water 35°C. NTP conditions are 760 mm of Hg and 0°C. Determine:
i) Mechanical efficiency
ii) The specific fuel consumption in $m^3$/I.P. hour.
iii) Indicated and brake thermal efficiencies.
Draw up a heat balance for the engine on minute basis. **(12 Marks)**

4 a. Explain the effect of: i) Maximum pressure, ii) Exhaust pressure, iii) Superheat, on the simple Rankine cycle. **(06 Marks)**

b. A regenerative cycle operates with steam supplied at 30 bar and 300°C and condenser of 0.08 bar. The extraction points for two heaters (open type) are at 3.5 bar and 0.7 bar. Calculate thermal efficiency of the plant, neglecting pump work. Show the T-S diagram. **(14 Marks)**

## PART – B

5 a. Obtain an expression for the volumetric efficiency of a single stage air compressor in terms of pressure ratio, clearance and 'n' the polytropic index. **(06 Marks)**

b. Why inter-cooling is necessary in multistage compression? **(04 Marks)**

c. A two stage air compressor with perfect inter-cooling takes in air at 1 bar and 27°C. The law of compression in both the stages is $pu^{1.3}$ = constant. The compressed air is delivered at 9 bar. Calculate for unit mass flow rate of air the minimum work done and the heat rejected to inter-cooler. Compare the values if compression is carried out in single stage compressor with after-cooler. **(10 Marks)**

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

b. With a neat sketch, explain working of Ramjet. **(04 Marks)**

c. A gas turbine power plant operates on the simple Brayton cycle with air as the working fluid and delivers 32 MW of power. Minimum and maximum temperatures in the cycle are 310 K and 900 K, and the pressure of air at the compressor exit is 8 times the value at the compressor inlet. Assuming an isentropic efficiency of 80% for the compressor and 86% for the turbine, determine the mass flow rate of air through the cycle. **(10 Marks)**

7 a. Draw a neat diagram of vapour-absorption refrigeration system with auxiliaries to improve its performance. Explain its principle of working briefly. **(08 Marks)**

b. Write a brief note on properties of refrigerants. **(04 Marks)**

c. An ammonia vapour compression refrigerator works between an evaporator pressure of 1.2 bar and a condenser pressure of 12 bar. The refrigerant leaves the evaporator at –20°C and leaves the condenser at +20°C. Determine the COP of the system and the power required per ton of refrigeration. **(08 Marks)**

8 a. Define the following terms:
i) Dry bulb temperature (DBT)
ii) Wet bulb temperature (WBT)
iii) Specific humidity (SH)
iv) Relative humidity (RH)
v) Degree of saturation (DS) **(10 Marks)**

b. For a hall to be air-conditioned, the following conditions are given:
Outdoor conditions 40°C DBT, 20°C WBT
Required comfort conditions 20°C DBT, 60% RH
Seating capacity of hall = 1500
Amount of outdoor air supplied 0.3 $m^3$/min per person.
If the required condition is achieved first by adiabatic humidification and then by cooling, estimate:
i) Capacity of the cooling coil in tonnes, and
ii) The capacity of the humidifier in kg/hr. **(10 Marks)**

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