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# Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019
## Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

**Note:** *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
*2. Use of thermodynamic data handbook is permitted.*



## PART – A

1 a. Draw P-V and T-S diagrams for a Diesel cycle. Derive an expression for air-standard efficiency in terms of compression ratio and cut off ratio. **(10 Marks)**

b. The compression ratio in an air-standard Otto cycle is 10. At the beginning of the compression stroke, the pressure is 0.1 MPa and the temperature is 15°C. The heat transfer to the air per cycle is 1800 kJ/kg of air. Determine
(i) Maximum pressure and temperature in cycle
(ii) The thermal efficiency
(iii) The mean effective pressure. **(10 Marks)**

2 a. With the help of a neat sketch, explain the exhaust gas analysis using Orsat apparatus. **(10 Marks)**

b. Methane ($CH_4$) is burned with atmospheric air. The analysis of the products on a dry basis is as follows:
$CO_2 = 10\%$ ; $O_2 = 2.37\%$ ; $CO = 0.53\%$ ; $N_2 = 87.1\%$
Calculate : i) Air-fuel ratio ii) Percent theoretical air iii) Combustion equation. **(10 Marks)**

3 a. With the help of a suitable graph, explain 'Willan's line method' of determining friction power in I.C. engines. **(10 Marks)**

b. The air flow to a 4 cylinder, 4 stroke oil engine is measured by means of a 5 cm diameter orifice having a coefficient of discharge of 0.6. During a test on the engine the following data were recorded : Bore = 10 cm; stroke = 12 cm ; speed = 1200 rpm ; brake torque = 120 Nm ; fuel consumption = 5 kg/h ; calorific values of fuel = 42000 kJ/kg ; pressure drop across orifice = 4.6 cm of water ; ambient temperature and pressure are 17°C and 1 bar respectively. Calculate : (i) Brake thermal efficiency (ii) Brake mean effective pressure (iii) Volumetric efficiency. **(10 Marks)**

4 a. With the help of a block diagram and T-S diagram, explain simple steam power plant that operates on the Rankine cycle. **(10 Marks)**

b. In a Rankine cycle, steam leaves the boiler and enters the turbine at 4 MPa and 400°C. The condenser pressure is 10 kPa.
(i) Determine the cycle efficiency
(ii) If the plant has to produce 500 MW of power, determine mass flow rate of water in kg/h. **(10 Marks)**

## PART – B

5 a. With the help of a block diagram, P-V and T-S diagrams, explain simple gas turbine power plant that operates on the Brayton cycle. Derive an expression for thermal efficiency in terms of pressure ratio. **(10 Marks)**

b. In an air-standard Brayton cycle the air enters the compressor at 0.1 MPa and 15°C. The pressure leaving the compressor is 1 MPa. The maximum temperature in the cycle is 1100°C. Determine : (i) Pressure and temperature at each point in the cycle (ii) The compressor work, turbine work and cycle efficiency (iii) If an ideal regenerator is introduced into the cycle, determine the thermal efficiency of the cycle. **(10 Marks)**

6 a. Obtain an expression for optimum intermediate pressure in case of a 2 stage reciprocating compressor with perfect intercooling. Also derive an expression for minimum work for the same. **(10 Marks)**

b. A 2 stage air compressor receives 0.238 $m^3/s$ of air at 100 kPa and 27°C and discharges it at 1000 kPa. The value of n for the compression is 1.35. Determine : (i) the minimum power necessary for compression (ii) the power for compression to the same pressure for one stage compression. (iii) Maximum temperature for both (i) and (ii). (iv) the heat removed in intercooler. **(10 Marks)**



7 a. With the help of block diagram, T-S and P-h diagram, explain the vapour compression refrigeration cycle. Write an expression for C.O.P. in terms of enthalpies at various state points. **(10 Marks)**

b. An ammonia ice plant operates between a condensers temperature of 35°C and as evaporator temperature of – 15°C. It produces 10 tons of ice per day from water at 30°C to ice at – 5°C. Assuming simple vapour compression refrigeration cycle, using only tables of properties of ammonia, determine : (i) Capacity of the refrigeration plant (ii) Mass flow rate of refrigerant (iii) Compressor power if adiabatic efficiency = 0.85 and mechanical efficiency = 0.95 (iv) Theoretical COP (v) Actual C.O.P. Assume $Cp_N$ = 4.1868 kJ/kgK, $Cp_{ice}$ = 1.94 kJ/kg K, Latent heat of fusion at 0°C = 335 kJ/kg. **(10 Marks)**

8 a. A mixture of dry air and water vapour is at a temperature of 21°C under a total pressure of 98.2 kPA (736mm of Hg). The dew point temperature is 15°C. Find : (i) Partial pressure of water vapour (ii) Relative humidity (iii) Specific humidity (iv) Enthalpy of air per kg of dry air (v) Specific volume of air per kg of dry air. Do not use psychrometric chart. **(10 Marks)**

b. The air handling unit of an air conditioning plant supplies a total of 4500 $m^3$/min of dry air which comprises by mass 20% fresh air at 40°C DBT and 27°C WBT and 80% recirculated air at 25°C DBT and 50% R.H. The air leaves the cooling coil at 13°C saturated state. Calculate the total cooling load and room heat gain. **(10 Marks)**

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