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10ME/AU43

**Fourth Semester B.E. Degree Examination, June 2012**  
**Applied Thermodynamics**

Time: 3 hrs.

Max. Marks:100

**Note: Answer FIVE full questions, selecting  
at least TWO questions from each part.**

**PART – A**

- 1 a. Explain the following with reference to a combustion process:
  - i) Percent excess air
  - ii) Enthalpy of formation
  - iii) Adiabatic flame temperature
  - iv) Enthalpy of combustion. (08 Marks)
- b. The products of combustion of an unknown hydrocarbon  $C_x H_y$  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 and
  - iv) Dew point temperature of the product if the total pressure of the product is 1.01325 bar. (12 Marks)
- 2 a. Derive an expression for efficiency of diesel cycle in terms of compression ratio, cut-off ratio and specific heats ratio. (08 Marks)
- b. An air-standard limited pressure cycle has a compression ratio of 15 and compression begins at 0.1 MPa, 40 °C. The maximum pressure is limited to 6 MPa and the heat added is 1675 kJ/kg. Compute:
  - i) The heat supplied at constant volume per kg air
  - ii) The heat supplied at constant pressure
  - iii) The cycle efficiency
  - iv) The cut-off ratio and
  - v) m.e.p of the cycle. (12 Marks)
- 3 a. Explain the 'William's line method for calculating the frictional power in an IC Engine. (04 Marks)
- b. A test on a two-stroke engine gave the following results at full load:  
 Speed = 350 rpm, Net brake load = 65 kgf, m.e.p = 3 bar, Fuel consumption = 4 kg/h,  
 Jacket cooling water flow rate = 500 kg/h, Jacket cooling water temperature rise = 20 °C,  
 Air used per kg of fuel = 32 kg, Cylinder diameter = 22 cm, Stroke = 28 cm,  
 Effective brake drum diameter = 1 m, CV of fuel = 43 MJ/kg,  $C_{p_g} = 1$  kJ/kg,  
 Exhaustgas temp = 400 °C, Room temperature = 20 °C.  
 Find the mechanical efficiency and also draw a heat balance sheet on minute and percentage basis. (10 Marks)
- c. A 4-cylinder petrol engine has a rated output of 52 kW at 2000 rpm. A Morse test is carried out and the brake torque readings are 177, 170, 168 and 174 N-m respectively. For normal running at this speed, the BSFC is 0.25 kg/kW-h and C.V of fuel used is 42500 kJ/kg. Calculate the mechanical and brake thermal efficiency. (06 Marks)
- 4 a. Draw a schematic diagram and show the actual regenerative vapour power cycle. Also derive an expression for its efficiency. (08 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
 2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

- b. An ideal Rankine cycle with reheat is designed to operate according to the following specification:

Pressure at the inlet of HP turbine = 20 MPa.

Temperature of steam at the inlet of HP turbine = 550 °C.

Temperature of steam at the end of reheat = 550 °C.

Pressure of steam at the turbine exit = 15 kPa

Quality of steam at the turbine exit = 90%. Determine:

- |  |                                  |            |
|--|----------------------------------|------------|
| i) Reheat pressure                     | ii) Temperature in the condenser |            |
| iii) Ratio of pump work to turbine and | iv) Cycle thermal efficiency.    | (12 Marks) |

### **PART – B**

- 5 a. What are the advantages of multi-stage compression? (04 Marks)
- b. Derive an expression for volumetric efficiency of a single stage reciprocating air compressor in terms of clearance factor (K), pressure ratio  $\left(\frac{P_2}{P_1}\right)$  and index of compression (n). (04 Marks)
- c. A single acting, two-stage air-compressor delivers air at 17 bar when the pressure and temperature of air at the end of suction are 1 bar and 303 k. The interstage pressure is 4 bar and there is perfect intercooling. If LP cylinder diameter is 23 cm and common stroke is 15 cm and speed of the compressor is 350 rpm. Determine:
- Volumetric efficiency of LP stage compressor.
  - Heat transfer in the inert cooler in kJ/min and
  - Capacity of the motor required to drive the compressor if the mechanical efficiency is 85%.
- Assume the clearance volume of LP compressor = 5% of stroke volume. The compression and expansion in both cylinders follow the law  $PV^{1.25} = \text{constant}$ . (12 Marks)
- 6 a. What are the advantages of closed cycle gas turbine over the open cycle gas turbine plant? (04 Marks)
- b. Write a short note on jet-propulsion. (04 Marks)
- c. In an open cycle gas turbine plant, air enters the compressor at 1 bar and 27 °C. The pressure after compression is 4 bar. The isentropic efficiencies of the turbine and compressor are 85% and 80% respectively. Air fuel ratio is 80:1. Calorific value of the fuel used is 42000 kJ/kg. Mass flow rate of air is 2.5 kg/s. Determine the power output from the plant and the cycle efficiency. Assume  $C_p$  and  $\gamma$  to be same for both air and products of combustion. (12 Marks)
- 7 a. Sketch and explain the Ammonia-Water absorption refrigeration system. (08 Marks)
- b. What are the desirable thermodynamics and thermo-physical properties of a good refrigerant? (04 Marks)
- c. In an air-refrigeration plant working on a reversed Brayton cycle, air enters into the compressor at 1 bar and -15 °C, where it is compressed to a pressure of 5.5 bar. Air enters the expander at 15 °C. Determine:
- COP of the cycle and
  - Mass flow rate of air into the compressor per minute for 1 ton of refrigeration.
- Assume both compression and expansion process are isentropic. (08 Marks)
- 8 a. Derive an expression for specific humidity of air-water vapour mixture. (06 Marks)
- b. Sketch and explain the winter air-conditioning showing the processes on a psychrometric chart. (07 Marks)
- c. The dry and wet temperatures of atmospheric air at 101.325 KPa pressure are measured with a sling psychrometer and determined to be 25 °C and 15 °C respectively. Determine:
- Dew point temperature
  - Specific humidity
  - Relative humidity and
  - Enthalpy of moist air.
- Use properties of table only, without using psychrometric chart. (07 Marks)

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