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10ME/AU43

# Fourth Semester B.E. Degree Examination, June/July 2014
## 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 thermodynamics data hand book permitted.*



### PART – A

1 a. Define:
i) Stoichiometric air
ii) Enthalpy of formation
iii) Enthalpy of reaction
iv) Adiabatic flame temperature. **(08 Marks)**

b. The products of combustion of an unknown hydrocarbon $C_xH_y$ have the following composition as measured by an ORSAT apparatus: $CO_2$ = 8%, CO = 0.9%, $O_2$ = 8.8%, $N_2$ = 82.3%. Determine:
i) The composition of fuel.
ii) Air-fuel ratio.
iii) Percentage excess air. **(12 Marks)**

2 a. Derive an expression for mean effective pressure of an Otto cycle. **(08 Marks)**

b. An air-standard diesel cycle has an compression ratio of 14. The pressure at the beginning of compression stroke is 98.1 kPa and temperature is 27°C. The maximum temperature of the cycle is 2500°C. Determine: i) Temperature at all salient points; ii) Thermal efficiency; iii) Mean effective pressure. **(12 Marks)**

3 a. Explain 'Willan's line method' of determining the friction power of an IC engine. **(04 Marks)**

b. The following data were obtained on MORSE test of 4-cylinder four stroke SI engine coupled to a hydraulic dynamometer operating at constant speed of 1500rpm, brake load with all four cylinders firing = 296N, brake load with first cylinder not firing = 201N, brake load with second cylinder not firing = 206N, brake load with third cylinder not firing = 192N, brake load with fourth cylinder not firing = 200N. Brake power in kW is calculated using the equation BP = WN/42,300, where 'W' is brake load in Newton, N-speed of the engine in RPM. Calculate: i) Brake power; ii) Indicated power; iii) Mechanical efficiency. **(06 Marks)**

c. In a trial of a single cylinder two-stroke engine, the following observations were made: Compression ratio = 15, fuel consumption = 10.2 kg/hr, calorific value of the fuel = 43,890 kJ/kg, air consumption = 3.8 kg/min, speed = 1900 rpm, torque on brake drum = 186 N-m, quantity of cooling water used = 15.5 kg/min, temperature rise of cooling water = 36°C. Exhaust gas temperature = 410°C, room temperature = 20°C,
specific heat of exhaust gas = 1.17 kJ/kg-K. Calculate: i) Brake power; ii) BSFC; iii) Brake thermal efficiency; iv) Draw heat balance sheet. **(10 Marks)**

4 a. With a schematic diagram, explain the working of reheat vapour power cycle and deduce an expression for cycle efficiency. **(08 Marks)**

b. Steam at 20 bar, 360°C is expanded in steam turbine to 0.08bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler.

i) Assuming ideal process, find per kg of steam, the net work and cycle efficiency.

ii) If the turbine and pump each have 80% efficiency. Find percentage reduction in net work and cycle efficiency. **(12 Marks)**

## PART – B

5 a. Derive an expression for minimum work required by a two stage air compressor with perfect inter cooling between stages. **(10 Marks)**

b. A single stage, double acting air compressor, required to deliver $14m^3$ of air per minute measured at 1.013 bar and 15°C. The delivery pressure is 7 bar and speed is 300rpm. Take the clearance volume as 5% of swept volume with the compression and expansion index $\eta = 1.3$. Calculate: i) the swept volume of cylinder; ii) delivery temperature; iii) indicated power. **(10 Marks)**

6 a. Explain the different methods of improving the efficiency of Brayton cycle. **(08 Marks)**

b. A gas turbine unit receives air at 1 bar and 300K and compress it adiabatically to 6.2 bar. The compressor efficiency is 88%. The fuel has a heating value of 44186 kJ/kg and fuel-air ratio is 0.017 kg/kg of air. The turbine efficiency is 90%. Calculate the work of turbine and compressor per kg of air compressed and thermal efficiency. For products of combustion, $C_p = 1.147$ kJ/kg-k and $\gamma = 1.333$. **(12 Marks)**

7 a. Derive an expression for COP of air refrigeration system working on Bell Colemann cycle. **(05 Marks)**

b. What are the desirable properties of good refrigerants? **(03 Marks)**

c. An air refrigeration plant is to be designed according to the following specifications. Pressure of the air at compressor inlet = 101 kPa, pressure at compressor exit = 404 kPa. Pressure loss in cold chamber = 3kPa, pressure loss in intercooler = 12 kPa, temperature of air at compressor inlet = -6°C, temperature of air at turbine inlet = 27°C, isentropic efficiency of compressor = 85%, isentropic efficiency of turbine = 85%. Determine: i) COP of cycle; ii) Power required to produce 1 ton of refrigeration; iii) Air circulation rate per ton of refrigeration. **(12 Marks)**

8 a. Define: i) Specific humidity; ii) Relative humidity; iii) Degree of saturation. **(06 Marks)**

b. With a neat sketch, describe the working of summer air conditioning system for hot and dry weather. **(06 Marks)**

c. Moist air at 35°C has a dew point of 15°C. Calculate its relative humidity, specific humidity and enthalpy. **(08 Marks)**

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