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06ME43

Fourth Semester B.E. Degree Examination, June/July 2013
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 hand book permitted.

PART – A

1 a. Explain the following: i) Enthalpy of formation; ii) Combustion efficiency; iii) Adiabatic flame temperature; iv) Percentage excess air. **(12 Marks)**

b. Propane (C_3H_8) is burnt in atmospheric air and the analysis of the dry products of combustion is as follows: CO_2 – 12.19%, CO – 1.23%, O_2 – 7.57% and the balance N_2. Determine: i) The volumetric analysis of the dry products.
ii) Percent theoretical air. **(08 Marks)**

2 a. Derive the expression for the air standard efficiency of a dual cycle with usual notations. **(10 Marks)**

b. An air standard diesel cycle has a compression ratio of 16. The temperature before compression is 27°C and the temperature after expansion is 627°C. Determine:
i) Network output per unit mass of air; ii) Thermal efficiency; iii) Specific air consumption in kg/hr. **(10 Marks)**

3 a. State the fundamental differences between the jet propulsion and rocket propulsion. **(03 Marks)**

b. Derive the expression of optimum pressure ratio for maximum network output in an ideal Brayton cycle. **(06 Marks)**

c. The pressure ratio of an open cycle gas turbine power plant is 5.6. Air is taken at 30°C and 1 bar. The compression is carried out in two stages with perfect inter cooling in between. The maximum temperature of the cycle is limited to 700°C. Assuming the isentropic efficiency of each compressor stage as 85% and that of turbine as 90%, Determine:
The power developed.
Efficiency of the power plant, if the air flow is 1.2 kg/sec. The mass of fuel may be neglected and it may be assumed that C_p = 1.02 kJ/kg K and γ = 1.41. **(11 Marks)**

4 a. With the help of a schematic diagram and T-S diagram, explain the working of a regenerative vapour power cycle and derive an expression for its overall efficiency. **(10 Marks)**

b. A 40 MW steam power plant working on Rankine cycle operates between boiler pressure of 4MPa and condenser pressure of 10 kPa. The steam leaves the boiler and enters the steam turbine at 400°C. The isentropic efficiency of the steam turbine is 85%. Determine:
i) The cycle efficiency; ii) The quality of steam from the turbine; iii) The steam flow rate in kg/hr. Consider pump work. **(10 Marks)**

PART – B

5 a. Derive and expression for the ideal volumetric efficiency of a reciprocating compressor in terms of the pressure ratio, clearance and "n" the exponent of expansion and compression. Discuss the effects of pressure ratio and clearance on the volumetric efficiency. **(10 Marks)**

b. A single-stage single-acting air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke are 30°C and 1 bar. The fore and stroke of the compressor are 100mm and 150mm respectively. The clearance is 3% of the swept volume. Assuming the index of compression and expansion to be 1.3, find:
i) Volumetric efficiency of the compressor.
ii) Power required if the mechanical efficiency is 85%.
iii) Speed of the compressor (r.p.m.). **(10 Marks)**

6 a. Derive an expression for COP of an air refrigeration system when compression and expansion are polytropic ($pv^n = c$). **(08 Marks)**

b. Explain the effect of super heat and sub cooling on the vapour compression refrigeration cycle. **(06 Marks)**

c. A vapour compression refrigerator operates between the temperature limits of -20°C and +30°C. The refrigerant used in Freon-12. The vapour enters the compressor dry and under cooled by 5°C in the condenser. For a capacity of 15 TOR, find:

i) C.O.P.
ii) Mass of Freon.
iii) Power required.

c_p for vapour = 0.56 kJ/kg K
c_p for liquid = 1.003 kJ/kg K. **(06 Marks)**

7 a. With a neat sketch describe the working of summer air conditioning system for hot and dry weather. **(07 Marks)**

b. Explain briefly the following:

i) Specific humidity
ii) Relative humidity
iii) Degree of saturation. **(06 Marks)**

c. Atmospheric air at 101.325 kPa has 30°C DBT and 15°C DPT. Without using the psychrometric chart, using the property values from the tables, calculate:

i) Partial pressure of air and water vapour.
ii) Specific humidity
iii) Relative humidity
iv) Vapour density
v) Enthalpy of moist air. **(07 Marks)**

8 a. Explain briefly the Morse test. **(06 Marks)**

b. The following observations were made during a trial of a single cylinder four stroke gas engine having cylinder diameter of 18cm and a stroke of 24cm.

Duration of trial	= 30 min
Total number of revolutions	= 9000
Total number of explosions	= 4450
IMEP	= 5 bar
Net load on the brake wheel	= 390N
Effective diameter of brake wheel	= 1m
Calorific value of gaseous fuel at NTP	= 19 MJ/m^3
Total fuel used at NTP	= 2.4m^3
Total air used	= 36m^3
Pressure of air	= 720mm of mercury
Density of air at NTP	= 1.29 kg/m^3
Temperature of air	= 17°C
Temperature of exhaust gases	= 350°C
Specific heat of exhaust gases	= 1.0 kJ/kg K
Room temperature	= 17°C
Cooling water circulated	= 80 kg
Rise in water temperature	= 30°C

Draw up a heat balance sheet for 30 minutes and estimate the mechanical and indicated thermal efficiencies of the engine. **(14 Marks)**

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