SE - sem-III - Mechanical - TP
(CBSGS)
20/5/15

QP Code : 4775

(3 Hrs) **[Total Marks : 80**

- **Question No 1 is compulsory.**
- **Answer any three out of remaining five questions.**
- **Assumptions made should be clearly stated .**
- **Assume suitable data wherever required, but justify the same.**
- **Use of Mollier Chart, Steam Table, permitted.**

1 Answer any **Four** of the following : [20]

a) Prove that energy is a property of the system

b) Explain how heat pump is more efficient for heating application than electrical heating.

c) Determine the maximum work obtainable from a Heat Engine exchanging heat with two finite bodies of equal heat capacities at temperatures T_1 and T_2

$(T_1 > T_2)$

d) What is cut off ratio. Discuss its effect on the thermal efficiency of Diesel Engine.

e) Define Joule Thompson Coefficient and explain its significance.

f) Write a note on Adiabatic Flame Temperature.

2 a) State and explain the equivalence of Kelvin Planck and Clausius statements of Second Law of Thermodynamics. [6]

b) A reciprocating air compressor takes in 2 m^3 /min at 0.11 MPa, 20 ° C , which it delivers at 1.5 MPa , 111 ° C to an aftercooler where the air is cooled at constant pressure to 25 ° C . The power absorbed by the compressor is 4.15 kW. Determine the heat transfer in the compressor and the aftercooler. [10]

c) Define COP of Heat Pump and refrigerator and derive the relationship between the two. [4]

Q 3 a) Two kg of air at 500 kPa , 80^0 C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100 kPa ,5^0 C . For this process determine (i) the maximum work (ii) the available energy (iii) the irreversibility. [10]

b) A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from heat pump are used to heat the water circulating through the radiators of the building. The efficiency of the heat engine is 27 % and the COP of the pump is 4. Evaluate the ratio of heat transfer to the circulating water to the heat transfer to the heat engine. [10]

4 a) Plot the Rankine cycle on T-S diagram and derive an expression for thermal efficiency of the cycle. List different methods of improving the performance of the cycle .Discuss any one method in brief. [8]

[TURN OVER

b) Water at 40 ° C is continuously sprayed into a pipeline carrying 5 tons of steam per hour at 5 bar, 300 ° C .At a section downstream where the pressure is 3 bar, the quality is to be 95 %. Find the rate of water spray in kg/hr. [6]

c) Derive an expression for ratio of Heat Capacities (γ) in terms of isothermal compressibility (k) and adiabatic compressibility (k_S). [6]

a) A cylinder contains 0.084 m^3 of hydrogen at 1.05 bar and 18^0 C. It is compressed adiabatically to 14 bar and then expanded isothermally to the original volume. The characteristic constant for hydrogen is 4200 kJ/kg K and its specific heat at constant pressure is 14.29 kJ/kg K. Determine the final pressure of the gas and the amount of heat added during isothermal expansion. Also find the amount of heat which must be extracted from the gas to reduce it to initial state of pressure. [10]

b) An engine working on dual cycle uses a compression of 14. The intake pressure and temperature are 1 bar and 330 K. The explosion ratio is 1.4.The heat supplied during constant pressure process is twice that at the constant volume process. Determine per kg of air (i) the percentage cut-off ratio (ii) work done and (iii) air standard efficiency. [10]

a) An engine uses n butane (C_4H_{10}) as liquid fuel. It is supplied with 40% excess air. Both fuel and air enter at 1 atmosphere pressure and 298 K. The products of combustion leave at 600 K .Heat lost to the surroundings is 30 % of power. The engine develops 60 kW of power. Determine the mass flow rate of fuel in kg/hr. The following data is applicable : [10]

Substance	h_f^0 (kJ/kgmole)	h_{298K} (kJ/kgmole)	h_{600K} (kJ/kgmole)
C_4H_{10} (l)	-126150	0	-
O_2 (g)	0	8624	18260
N_2 (g)	0	8660	17569
CO_2 (g)	-241830	8769	22285
H_2O (g)	-393520	9856	20402

b) In a single heater regenerative cycle the steam enters the turbine at 30 bar 400 ° C and the exhaust pressure is 0.10 bar. The feed water heater is a direct contact type which operates at 5 bar. Determine : [10]

i) The efficiency and steam rate of cycle
ii) The increase in efficiency and steam rate as compared to Rankine Cycle without regeneration.
