Registration no: | | | | | | | | | | |

Total Number of Pages: 01

M.Tech
P2HTCC01

2nd Semester Regular Examination 2016-17

Advanced Engineering Thermodynamics

BRANCH: HEAT POWER & THERMAL ENGG, HEAT POWER ENGG, THERMAL & FLUID ENGG, THERMAL ENGG.

Time: 3 Hours

Max Marks: 100

Q.CODE : Z343

Answer any Five questions including Q. No. 1which is compulsory
Use of standard tables and charts are permitted

Q1 **Answer the following questions:** (2 x 10)

a) A 1-m^3 tank is filled with a gas at room temperature (20^oC) and pressure (100 kPa). How much mass is there if the gas is a. air, b. oxygen

b) A closed vessel contains 0.1 m^3 of saturated liquid and 0.9 $m^3$of saturated water vapor in equilibrium at 200 kPa. Determine the percent vapor on a mass basis.

c) A refrigerator removes 1.5 kJ from the cold space using 1 kJ work input. How much energy goes into the kitchen, and what is its coefficient of performance?

d) Explain the concept of principle of increase of entropy.

e) An inventor claims to develop an adiabatic, steady flow turbine such that the entropy at the exit is less than entropy at inlet. Is the claim true? Justify.

f) Does the temperature in the clausius inequality relations have to be absolute temperature? Why?

g) What is the second law efficiency? How does it differ from the first-law efficiency?

h) A heat engine receives heat from a source at 1200 K at a rate of 500kJ/s and rejects the waste heat to a medium at 300 K. The power output of the heat engine is 180 kW. Determine the reversible power and the irreversibility rate for this process.

i) Define the term air-fuel ratio. How is it related to the fuel-air ratio?

j) What do you mean by enthalpy of formation?

Q2 a) Air at 300 kPa and 200^oC is in a piston/cylinder arrangement with a volume of 0.1 m^3. It is now compressed in a polytropic process with exponent n=1.2 to a final temperature of 300^oC. Calculate the heat transfer for the process. (10)

b) A vessel having a volume of 5 m^3 contains 0.05 m^3 of saturated liquid water and 4.95 m^3 of saturated water vapor at 0.1 Mpa. Heat is transferred until the vessel is filled with saturated vapor. Determine the heat transfer for this process. (10)

Q3 a) A nozzle receives 0.1 kg/s of steam at 1 MPa and 400^oC with negligible kinetic energy. The exit is at 500 kPa and 350^oC, and the flow is adiabatic. Find the nozzle exit velocity. (10)

b) A rigid, insulated tank that is initially evacuated is connected through a valve to a supply line that carries steam at 1 MPa and 300^oC. Now the valve is opened, (10)

and steam is allowed to flow slowly into the tank until the pressure reaches 1MPa, at which point the valve is closed. Determine the final temperature of the steam in the tank.

Q4 (a) A heat engine is used to drive a heat pump. The heat coming out of the heat engine and the heat pump are used to heat the water for the radiator of a building. The efficiency of the heat engine is 30% and the COP of the heat pump is 4. How much heat is transferred to the radiator water for every kJ heat transferred to heat engine? (10)

(b) A reversible heat engine operates between two reservoirs at 827^{o}C and 27^{o}C. Engine drives a Carnot refrigerator maintaining -13^{o}C and rejecting heat to reservoir at 27^{o}C. Heat input to the engine is 2000kJ and the net work available is 300 kJ. How much heat is transferred to refrigerant and total heat rejected to reservoir at 27^{o}C? (10)

Q5 a) Determine the change in entropy of 0.5 kg of air compressed polytropically from 1bar to 0.8 MPa and 800 K following index 1.2. Take C_v=0.718kJ/kg-K (10)

b) Two tanks are connected through a pipe with valve in between. Initially valve is closed and tanks A and B contain 0.6 kg of air at 90^{o}C, 1 bar and 1 kg of air at 45^{o}C, 2 bar respectively. Subsequently valve is opened and air is allowed to mix until equilibrium. Considering the complete system to be insulated determine the final temperature, final pressure and entropy change. (10)

Q6 a) 500 kJ of heat is removed from a constant temperature heat reservoir maintained at 835K. Heat is received at constant temperature of 720K. Temperature of the surroundings, the lowest available temperature is 280K. Determine the net loss of available energy as a result of this irreversible heat transfer. (10)

b) A steam turbine has steam flowing at steady rate of 5kg/s entering at 5 MPa and 500^{o}C and leaving at 0.2 MPa and 140^{o}C. During flow through turbine a heat loss of 600kJ/s occurs to the environment at 1 atm and 25^{o}C. Determine (10)
(i) the availability of steam at inlet to turbine,
(ii) the turbine output
(iii) the maximum possible turbine output, and
(iv) the irreversibility.

Q7 a) A mixture of 1kmol of gaseous ethane and 3kmol of oxygen at 25^{o}C reacts in a constant-volume bomb. Heat is transferred until the products are cooled to 600K. Determine the amount of heat transfer from the system. (10)

b) Discuss (10)
(i) Enthalpy of combustion
(ii) Adiabatic flame temperature