Reg.No.										

MANIPAL INSTITUTE OF TECHNOLOGY

Manipal University, Manipal – 576 104

III SEM. B.Tech. (MECHANICAL ENGG.) END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: THERMODYNAMICS - I (MME 2101)

REVISED CREDIT SYSTEM

Time: 3 Hours. MAX.MARKS: 50

Instructions to Candidates:

- Answer **all the** questions.
- Missing data if any, may be suitable assumed
- Use of Thermodynamic data hand book/steam tables is permitted.

1A State the first law of thermodynamics when a closed system undergoes (i) Change of state (ii) Thermodynamic cycle **2**

1B What are the assumptions made in the derivation of SFEE?
Write the SFEE with usual notations and reduce the same under ideal conditions for the following cases (i) Turbine (ii) Adiabatic nozzle **4**

1C Air at 101.325kPa, 20°C is taken into a gas turbine power plant at a velocity of 140 m/s through an opening of 0.15m^2 cross-sectional area. The air is compressed, heated, expanded through the plant, and exhausted at 0.18MPa, 150°C through an opening of 0.10m^2 cross sectional area. The net power output of the gas turbine plant is 375kW. Calculate the net amount of heat added to the air in kJ/kg. Assume that air obeys the ideal gas law and take c_p = 1.005 kJ/kg K. **4**

2A Define (i) Heat Pump (ii) Refrigerator (iii) Heat Engine (iv) Thermal Reservoir (v) Point function (vi) Path function **3**

2B Write the two statements of second law of thermodynamics. **3**

2C A heat pump working on a reversed Carnot cycle takes in energy from a reservoir maintained at 5°C and delivers it to another reservoir where temperature is 77°C. The heat pump derives power for its operation from a reversible engine operating within the higher and lower temperatures of 1077°C and 77°C. For 100 kJ/kg of energy supplied to reservoir at 77°C, estimate the energy taken from the reservoir at 1077°C. **4**

3A Define entropy. Show that it is a property of the system. **2**

3B Write the Carnot cycle on a P-v co-ordinate and show that efficiency is a function of temperature only. **4**

3C Two streams of steam, one at 2MPa, 300°C and the other at 2MPa, 400°C, mix in a steady flow adiabatic process. The rates of flow of the two streams are 3kg/min and 2kg/min respectively. Evaluate the final temperature of the emerging stream, if there is no pressure drop due to the mixing process. What would be the rate of increase in the entropy of the universe? This stream with a negligible velocity now expands adiabatically in a nozzle to a pressure of 1kPa. Determine the exit velocity of the stream and the exit area of the nozzle. **4**

4A List the causes of irreversibility and explain any one of them **3**

4B Write the phase general equilibrium diagram (P-T diagram) for the pure substance and locate all the phases and phase boundaries. **3**

4C A rigid vessel contains a mixture of 1kg of carbon monoxide (CO) and 1kg of hydrogen (H_2) at a pressure of 1bar and a temperature of 18 ^{o}C. Assuming CO and H_2 to be ideal gases, evaluate:

(a) The partial pressures of the components.
(b) The volume and specific volume of the mixture.
(c) The volume fraction.
(d) The Gas constant for the mixture **4**

5A Define (i) Mole fraction (ii) Mass fraction (iii) Partial pressure (iv) Volume fraction **2**

5B Obtain a general expression for entropy change of an ideal gas as a function of pressure ratio and temperature ratio between the given end states. **4**

5C An ideal gas of molecular weight of 30 and γ = 1.3, occupies a volume of 1.5m^3 at 100kPa and 77^{0}C. The gas is compressed according to the law $PV^{1.25}$ = Constant to a pressure of 3MPa. Calculate the volume and temperature at the end of compression, change in internal energy, heat transferred and total change in entropy. Given C_v= 0.72kJ/kg K **4**