Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

III SEMESTER B. TECH (MECHANICAL ENGG.) END SEMESTER

MAKE-UP EXAMINATIONS, DECEMBER 2018

SUBJECT: THERMODYNAMICS - I [MME 2101]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Use of Thermodynamics data hand book is permitted

1A. Distinguish between:
(i) Macroscopic and microscopic point of views.
(ii) Intensive and extensive properties. **2**

1B. Gas in a cylinder sealed by a freely sliding piston of negligible mass receives 5kJ of heat and expands by $0.14m^3$ against an atmosphere which is at a pressure of 1.013254bar. Through a lever system actuated by the piston a mass of 4.5kg is also raised through a distance of 1.5m. Find the change in internal energy of the gas. **3**

1C. A centrifugal air compressor delivers 900kg of air per hour at 5 bar. The inle conditions are velocity 5m/s, specific volume $0.8m^3$/kg. The discharge conditior is with specific volume of $0.15m^3$/kg. The increase in enthalpy of air pressure through the air compressor is 168kJ/kg and heat loss to the cooling water anc surrounding air is 15kW. The ratio of inlet to outlet pipe diameter is 4. Find the power required to drive the compressor. **5**

2A. Define entropy and show that it is a property of the system **2**

2B. Write the Kelvin Plank and Clausius statements of second law of thermodynamics. Show that they are equivalent statements. **3**

2C. Using an engine of 30% thermal efficiency to drive a refrigerator having a COP of 5, what is the heat input into the engine for each MJ of heat removed from the cold body by the refrigerator?
If the system is used as a heat pump how many MJ of heat would be available for heating for each MJ of heat input to the engine?
Assume that heat engine, refrigerator and heat pumps are reversible. **5**

3A. Define the terms: Critical point, saturated liquid, saturated vapor and triple point as referred to pure substance **2**

3B. With a neat sketch explain the working of a combined separating and throttling calorimeter. How it is superior to throttling calorimeter? **3**

3C. Half kg of ice block at -10^0C is brought in contact with 10kg copper block at 150^0C in an insulated container. Determine the change in entropy of (i) Ice (ii) Copper block (iii) Universe. Assume that specific heat of ice = 2.1kJ/kg K, specific heat of water= 4.2kJ/kg K, Heat of fusion of ice = 335kJ/kg, Heat of vaporization of water at 100^0C = 2257kJ/kg, specific heat of steam = 2.1kJ/kg K. Specific heat of copper = 150J/kg K . **5**

4A. Define (i) Gas constant (ii) Universal gas constant **2**

4B. Derive an expression for change in entropy of an ideal gas in terms of specific heat ratio, pressure ratio, gas constant and temperature ratio. **3**

4C. A gas having a value of adiabatic index 1.66 is expanded from the same initial state (i) isothermally and (ii) adiabatically such that the pressure ratio is 5 in each case. Calculate the ratio of isothermal work done to adiabatic work done **5**

5A. Show that mole fraction is equal to volume fraction equal to partial pressure fraction. **2**

5B. A rigid vessel contains a mixture of 1kg of carbon monoxide and 1kg of hydrogen at a pressure of 1bar and a temperature of 18^o C. Assuming both Carbon monoxide and hydrogen to be ideal gases, Evaluate:(a) The partial pressures of the components. (b) The volume and specific volume of the mixture. (c) The mole fractions. (d) The Gas constant for the mixture **3**

5C. A rigid vessel contains a mixture of 1kg of carbon monoxide (CO) and 1kg of hydrogen (H_2) at a pressure of 200 kPa 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 volumetric analysis.
(d) The Gas Constant, the specific heats and γ of the mixture. **5**