Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institute of Manipal University, Manipal

III SEMESTER B.TECH (MECHANICAL/IP ENGG.) END SEMESTER EXAMINATIONS, NOV 2017

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. Define: System, Surrounding, Control volume and Property **2**

1B. Derive the expression for the work done for the following cases along with necessary P-V diagram: (i) Isobaric Process (ii) Isochoric Process (iii) Isothermal process (iv) Adiabatic Process **3**

1C. A cylinder contains 0.12 m^3 of air at 1 bar and 100^0 C. The air is compressed to 0.03 m^3. The final pressure being 6 bar. Determine (i) Polytropic Index (ii) Mass of air in the cylinder (iii) Increase in internal Energy (iv) Work done. Take γ =1.4, R=0.287 kJ/kg-K and C_v= 0.72 kJ/kg-K. **5**

2A. State the first law of thermodynamics as applied to (i) Closed system undergoing a change of state (ii) Closed system undergoing a thermodynamic cycle **2**

2B. Define (i) Enthalpy (ii) Internal energy
Show that enthalpy is a property of the system **3**

2C. A system is compressing of 0.95 kg of pure substance has specific internal energy of 16kJ/kg. The system is moving with a velocity of 120m/s at an elevation of 1500m. Evaluate the energy of the system relative the observer at rest at sea level. The above system undergoes a process to a final specific internal energy of 20kJ/kg, final velocity of 200m/s and final elevation of 270m. The work done on the system is 2200 N-m. Evaluate the magnitude and direction of heat transfer during the process. **5**

3A. State the two forms of second law of thermodynamics. **2**

3B. Apply the steady flow energy equations under ideal conditions and obtain the final equations for the following open systems: (i) Boiler (ii) Turbine (iii) Throttling valve (iv) Nozzle **3**

3C. A heat engine operating between two reservoirs at 727°C and 27°C is used to drive a heat pump which extracts heat from the reservoir at 27° at a rate twice that at which the engine rejects to it. If the efficiency of the engine is 40% of maximum possible and COP of the heat pump is 50% of the maximum possible, what is the temperature of the reservoir to which the heat pump rejects heat? What is the rate of heat rejection from the heat pump if the rate of heat supply to the engine is 50 kW? **5**

4A List the causes of irreversibility **2**

4B. Prove that two statements of second law of thermodynamics are equivalent statements. **3**

4C. A 30kg steel ball at 427^0C is dropped in 150kg of oil at 27^0C, the specific heat of steel and oil are 0.5kJ/kg K and 2.5kJ/kgK respectively. Estimate the entropy change of the steel, oil and that of the system containing oil and steel. **5**

5A. Define: (i) Entropy (ii) Pure substance **2**

5B. Write a short note on: (i) Steam Calorimeters (ii) Mollier diagram **3**

5C. The initial internal energy of 4.5 kg of wet steam at 7 bar is 11388 kJ. What is the dryness fraction of steam? Determine the change in internal energy, entropy and the enthalpy of the steam when it is superheated to 250^0 C at the same pressure. The steam is then expanded to 1 bar pressure isentropically in a steam turbine. Determine the specific work of the turbine. **5**