Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

III SEMESTER B.TECH. (MECHANICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: THERMODYNAMICS - I [MME 2101]

REVISED CREDIT SYSTEM
(25/11/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.
- Use of thermodynamics data hand book and steam tables permitted.

1A. Derive an expression for Vander Waals constants and modify it for critical state. **(05)**

1B. In a cooling tower air enters at a height of 1 m above the ground level and leaves at a height of 7 m. The inlet and outlet velocity are 20 m/s and 30 m/s respectively. Water enters at a height of 8 m and leaves at height of 0.80 m. The velocity of water at entry and exit are 3 m/s and 1 m/s respectively. Water temperature are 80°C and 50°C at the entry and exit. Air temperature are 30°C and 70°C at the entry and exit. The cooling tower is well insulated and a fan of 2.25 kW drives the air through cooler. Find the amount of air per second required for 1 kg/s of water flow. Cp_{air} = 1.005 kJ/kgK and Cp_{water} = 4.187 kJ/kgK. **(05)**

2A. With necessary diagrams, explain the difference between:

(a) Displacement work and flow work

(b) Control volume and control surface

(c) Heat and work **(05)**

2B. Two Carnot engines are working in series between a source and a sink. The first engine receives heat from a reservoir at a temperature of 1000 K and rejects heat to another reservoir at temperature T_2. The second heat engine receives the heat energy rejected by the first engine. It converts some of energy into useful work and rejects the rest to a reservoir at temperature of 300 K.

(a) If both engines deliver equal power, determine the efficiency of each engine.

(b) If both engines deliver equal efficiency, determine the power developed by each engine for heat input of 1000 kJ at 1000 K. **(05)**

3A. Show that internal energy is a property of system. **(02)**

3B. With neat sketch and h-s diagram explain the working principle of throttling calorimeter. **(03)**

3C. An iron cube at a temperature of 400°C is dropped into an insulated bath containing 10 kg water at 25°C. The water finally reaches a temperature of 50°C at steady state. Given that the specific heat of water is equal to 4186 J/kgK. Find the entropy changes for the iron cube and the water. Is the process is reversible or irreversible? If the process is irreversible, what should be the heat capacity of iron cube to make it reversible? **(05)**

4A. Explain the generalized compressibility chart. **(02)**

4B. State and prove Carnot's theorem. **(03)**

4C. A pressure cooker contains 2 kg of steam at 5 bar and 0.9 dry. Calculate the quantity of heat which must be rejected so as the quality of steam becomes 0.5 dry. Show the process on p-v, T-s and h-s diagrams. **(05)**

5A. State and Prove Clausius inequality. **(02)**

5B. Define:

(a) Dead State

(b) Available and unavailable energy

(c) High grade and low grade energy **(03)**

5C. An ideal gas cycle of three processes uses Argon ($\gamma = 1.67$) as a working substance. Process 1 – 2 is a reversible adiabatic expansion from 0.014 m^3, 700 kPa, 280°C to 0.056 m^3. Process 2 – 3 is a reversible isothermal process. Process 3 – 1 is a constant pressure process.

(a) Sketch the cycle on p-v and T-s diagrams

(b) Calculate net specific work in the cycle **(05)**