Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (AUTOMOBILE/ AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: THERMODYNAMICS [AAE 2104]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. With suitable sketches, explain the shaft work and electrical work. **(04)**

1B. Define the following terms: **(02)**

i. Heat
ii. Triple-point

1C. A unit mass of Nitrogen gas undergoes an expansion process as per the relation $P=a+bV^3$ where a = 1.2 bar/m^3 and 'b' is a constant. The initial pressure is 15 bar and initial temperature is 100°C while final volume is 100 liters. Calculate the displacement work done by the gas and heat transfer with the surroundings. **(04)**

2A. A pipe of diameter 20 cm supplies water at 15°C from one building to another. The pipe loses 500 W of heat to the surroundings. If the specific heat of water is 4.18 kJ/(kgK), Determine : **(03)**

i. Minimum mass flow rate so that the water should not freeze (i.e. reach 0°C)..
ii. Velocity of flow through the pipe.

2B. State and prove the Carnot's theorem with neat sketches. **(04)**

2C. 90 kJ of heat is supplied to a system at constant volume, the system rejects 95kJ of heat at constant pressure and 18kJ of work is done on it. The system is brought to its original state by an adiabatic process. Sketch the processes on a P-v plot. If the initial value of the internal energy is 105 kJ, Calculate **(03)**
(i) Adiabatic work done
(ii) Values of internal energy at all states.

3A. Prove the Clausius inequality theorem. **(04)**

3B. Sketch the P-v-T surface for a substance which contracts on freezing. **(02)**

3C. 3 kg of water vapor at 100°C and 70 kPa is stored in a rigid closed vessel. The vessel is cooled till the mixture attains a dryness of 0.9. Estimate the final temperature and pressure of the mixture inside the vessel. **(04)**

4A. A reversible heat engine receives heat from a high temperature reservoir at T_1 K and rejects heat to a low temperature sink at 1000K. A second reversible heat engine receives the heat rejected by the first engine at 1000K and rejects to a cold reservoir at 320K. Calculate the temperature 'T_1' for **(04)**
(i) Equal thermal efficiencies of the two engines,
(ii) Same amount of work delivered by the two engines.

4B. Define: **(02)**
i. Relative humidity
ii. Adiabatic saturation temperature

4C. A ceiling fan of diameter 1.2 m takes air in at 100 kPa and 24°C and delivers it at 105 kPa and 24.5°C with a velocity of 1.5 m/s. Calculate the mass flow rate, the inlet velocity of air and exit volume flow rate respectively. **(04)**

5A. With the aid of neat P-v and T-s plots for a diesel cycle, derive its thermal efficiency. **(05)**

5B. Calculate the power required for a refrigerator working on an ideal reversed Carnot cycle. The refrigerator needs to produce 40 kg of ice per hour at -10°C from water at 25°C. Assume no heat losses, take the specific heat of ice and water as 2 kJ/(kgK) and 4.18 kJ/(kgK) respectively and latent heat of fusion=335kJ/kg. **(03)**

5C. State the Zeroth Law of thermodynamics and mention its significance. **(02)**