Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

III SEMESTER B.TECH. (INDUSTRIAL AND PRODUCTION ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: THERMAL ENGINEERING [MME 2113]

REVISED CREDIT SYSTEM
(29/11/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. A gas undergoes a thermodynamic cycle consisting of the following processes: **4**

- Process 1- 2: Constant pressure, p= 1.4 bar, V_1= 0.028 m^3, W_{1-2}= 10.5 kJ
- Process 2- 3: Compression with pV= constant, U_3=U_2,
- Process 3- 1: Constant volume, U_1- U_3= -26.4 kJ.

There are no significant changes in KE and PE.

(i) Sketch the cycle on a p- V diagram
(ii) Calculate the net work for the cycle in kJ
(iii)Calculate the heat transfer for process 1- 2
(iv)Show that $\sum_{cycle} Q = \sum_{cycle} W$

1B. Derive the steady flow energy equation with a neat diagram. **3**

1C. A centrifugal air compressor delivers 900kg of air per hour at 5 bar. The inlet conditions are velocity 5m/s, specific volume 0.8m^3/kg. The discharge condition 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 and surrounding air is 15kW. The ratio of inlet to outlet pipe diameter is 4. Find the power required to drive the compressor. **3**

2A. Prove that the violation of Kelvin-Planck statement will violate Clausius statement with a neat sketch and vice versa. **4**

2B. Prove that the efficiency of a Carnot cycle is **3**

$$\eta_{camot} = 1 - \frac{\text{Low Temperature}}{\text{High Temperature}}$$

2C. The COP of heat pump is 6 when the power supplied is 40kW, Evaluate **3**
(i)The magnitude of heat transfer rates to and from the working fluid. The heat transfer from the heat pump is used to heat the water flowing through the radiator of a building.
(ii)Evaluate the mass flow rate of heated water given that the temperature increases from 50^0C to 70^0C.

3A. Compare Otto and Diesel cycle with **3**

- Same compression ratio and heat addition
- Same compression ratio and heat rejection
- Same peak pressure peak temperature and heat rejection.

3B. Air standard Otto cycle has the clearance volume of 17% of swept volume. Initial conditions are 0.95 bar and 30^0C. if the maximum pressure in the cycle is 28 bar, find (i) Air standard efficiency (ii) maximum temperature of the cycle (iii) MEP. **3**

3C. Compare the performance of simple Rankine cycle with boiler exit steam conditions of 20 bar and dry saturated with that of another simple Rankine cycle with boiler exit steam conditions of 30 bar and dry saturated in terms of (i) Net work output, (ii) heat supply, (iii) thermal efficiency, (iv) steam rate and (v) quality of steam entering the condenser. Assume the condenser pressure to be 0.06 bar for both the cycles **4**

4A. Derive the work done by the compressor on unit mass of air and show that clearance volume has no effect on it. **3**

4B. A double acting compressor, with a piston displacement of $0.05m^3$/ stroke, operates at 500 rpm. The clearance is 5% and it receives air at 100kPa and discharges at 6bar. The compression is polytropic according to the law $pV^{1.35}$ = constant. Determine the power required to drive the compressor and the mass of air delivered in kg/s if the suction temperature is 27^0C. **4**

4C. A two-cylinder, two stage air compressor delivers 2 kg/min of air at 25 bar, taking in air at 1 bar and 30^o C. The compression index is 1.25. Neglecting clearance calculate (i) the intermediate pressure for minimum power, (ii) heat transfer during inter-cooling and (iii) power required to drive the compressor. **3**

5A. With a neat sketch explain the working of a Bell Coleman cycle. **3**

5B. An ideal refrigeration unit working on Ammonia as the refrigerant has the condenser temperature of 30^0C and an evaporator temperature of -10^0C. The vapor at the end of compression is dry and saturated and the refrigerant leaves the condenser as saturated liquid. If the refrigerant flow rate is 100kg/hr, determine (a) COP (b) the capacity of unit in tones of refrigeration. **3**

5C. (i) Derive the expression for heat transfer by conduction on a composite wall. **4**
(ii) What is a grey body and state Stephen Boltzman's law.