Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

III SEMESTER B.TECH (INDUSTRIAL & PRODUCTION ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: THERMAL ENGINEERING [MME 2113]

REVISED CREDIT SYSTEM

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. Air flows steadily at the rate of 0.4 kg/s through an air compressor, entering at 6 m/s with a pressure of 1 bar and density of 1.176 kg/m^3, and leaving at 4.5 m/s with a pressure of 6.9 bar and density of 6.25 kg/m^3. The internal energy of the air leaving is 88 kJ/kg greater than that of the air entering. Cooling water jacket surrounding the cylinder absorbs heat from the air at the rate of 59 kW. Calculate the power required to drive the compressor and inlet and outlet cross-sectional areas. **(05)**

1B. With the use of P-V and T-s diagrams, derive an expression for air standard efficiency of an Otto cycle in terms compression ratio and specific heat ratio. **(05)**

2A. In a thermal power plant operating on an ideal Rankine cycle, superheated steam produces at 5 MPa and 500°C is fed to a turbine where it expands to the condenser pressure of 10 kPa. If the net power output of the plant is to be 20 MW, determine;

(i) Heat added in the boiler per kg of water

(ii) Thermal efficiency of the cycle,

(iii) Mass flow rate of steam in kg/s

(iv) Mass flow rate of cooling water in condenser if the cooling water enters the condenser at 25°C and leaves at 35°C. **(05)**

2B. State Fourier law of heat conduction. With a neat sketch and electrical analogy, derive an expression for total thermal resistance and overall heat transfer coefficient of the composite slab. **(05)**

3A. A two stage single acting air compressor delivers air at 20 bar. Pressure and temperature of air before compression in LP cylinder are 1 bar and 27°C. Discharge pressure in the LP cylinder is 4.7 bar. Pressure of the air leaving the intercooler is 4.5 bar and the air is cooled to 27°C. Diameter and stroke of

LP cylinder are 40 and 50 cm respectively. Clearance volume is 4% of stroke in both the cylinders. Speed of the compressor is 200 rpm. Assuming the index of compression as 1.3, find:

(i) Indicated power required to run the compressor

(ii) Heat rejected in the inter cooler per minute.

Draw the P-V and T-s diagram for the arrangement. **(05)**

3B. Derive an expression for Clausius inequality and entropy principle. **(05)**

4A. An ice plant working on a reversed Carnot cycle heat pump produces 15 tons of ice per day. The ice is formed from water at 0^oC and the formed ice is maintained at 0^oC. The heat is rejected to the atmosphere at 25^oC. The heat engine is used to run the ice plant which absorbs heat from a source which is maintained at 220^oC by burning liquid fuel of 44500 kJ/kg calorific value and rejects the heat to the atmosphere. Determine:

(i) Power developed by the engine.

(ii) Fuel consumed per hour.

Take enthalpy of fusion of ice = 334.5 kJ/kg. **(05)**

4B. A four cylinder 4 stroke petrol engine with a bore of 60 mm and stroke of 90 mm was tested at 3000 rpm. The load on hydraulic dynamometer is 160 N. The fuel consumption is 5 kg/h. Calorific value of the fuel is 44 MJ/kg. The temperature and the pressure at the end of the suction is 15^0C and 1 bar. Air fuel ratio is 13. For the determination of mechanical efficiency of the engine a Morse test was carried out by shorting the spark plug of each cylinder successively without change of the speed and the corresponding load on dynamometer are 110 N, 108 N,113 N and 111 N respectively. The BP (kW) is (W.N / 27900). Where W is the brake load in Newton and N is the engine speed in RPM. Determine:

(i) Mechanical, brake thermal and volumetric efficiency.

(ii) Break mean effective pressure and specific fuel consumption. **(05)**

5A. A standard vapor compression refrigerator using F-12 as the refrigerant operates between the condenser pressure of 10 bar and the evaporator pressure of 1.5 bar. The evaporator absorbs 75 kJ/min of energy as heat and the vapor is dry saturated at exit from the compressor. Represent the cycle on T-s and p-h diagram and calculate:

(i) Flow rate of refrigerant (ii) Power consumed (iii) COP of the cycle **(05)**

5B. With P-V diagram, derive an expression for work done in case of Isothermal and Adiabatic process. **(03)**

5C. Distinguish between:

(i) Macroscopic and microscopic point of views.

(ii) Intensive and extensive properties. **(02)**