Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institute of Manipal University, Manipal

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

SUBJECT: DESIGN OF THERMAL POWER PLANT SYSTEMS (P-6) [MME 4010]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL the** questions.
- Missing data may be suitably assumed.
- Use of heat exchanger data sheet, thermodynamics and heat transfer data book are permitted

1A. With a neat sketch explain the furnace based natural loop steam generating unit taking into account various heat exchangers. **05**

1B. Engine oil flowing at a rate of 2 kg/s need to be cooled from 100°C to 60°C in a double pipe heat exchanger with raw water(entry temperature = 20°C, flow rate = 2.04 kg/s) as coolant. The following design data are selected:

Annulus nominal diameter	=	5″, Schedule 40
Inner pipe nominal diameter	=	¾″, Schedule 40
Fin height	=	0.0127 m
Fin thickness	=	0.90 mm
Number of fins/tube	=	30
Number of tubes in the annulus	=	2

Calculate oil and water side convective heat transfer coefficient. **05**

2A. Explain with neat sketches the different zones of condensation in horizontal tube. **05**

2B. A shell and tube heat exchanger is meant for heating treated water by the use of engine oil which enters the tubes at 70°C and 50000 kg/h. As a coolant water enters at 30°C, 30000 kg/h and leaves at 50°C. Two tube pass with total number of 124 tubes is preferred. Tube thickness is 20 BWG. Take baffle spacing as $0.6D_s$. Consider tube side convective coefficient as 15.2 W/m^{2}K. Tube material is carbon steel (0.5% C). Don't consider the effect of variable physical property in convective coefficient calculation.
Find the length of the heat exchanger based on TEMA standards. **05**

3A. Sketch and explain a natural draught cooling tower. Define various cooling tower parameters. **05**

3B. Air enters at 1 atmosphere and 30°C the core of a circular finned tube matrix (surface CF-872 (C)). The air flows at the rate of 1618 kg/h perpendicular to the tubes and exits with a temperature 90°C. The core is 0.5 m long with 0.25 m^2 frontal area. Calculate the total pressure drop between air inlet and outlet and average heat transfer coefficient on the air side. **05**

4A. With schematic, explain the hot fluid series/cold fluid parallel and cold fluid series/ hot fluid parallel arrangements in double pipe heat exchanger. State its necessity. **05**

4B. A condenser is to be designed to condense 163 kg/h of steam at atmospheric pressure. A square array of 100, 10 mm outside diameter tubes are available for the design and the wall temperature of the tube is maintained at 98°C.

(a) Estimate the length of the tube required (by referring Kern relation), if the condenser is to be installed in the horizontal position.

(b) If the above condenser is by mistake installed in the vertical position, will there be any change in the condensation rate? If so find the modified value. **05**

5A. Fired heater is used to heat the process fluid having flow rate of 200000 kg/h from 200°C to 350°C. Assume the stack gas temperature to be 100°C more than the process fluid inlet temperature. Propane (M= 44.1) is used as the fuel with 15 % excess air. Take radiation loss as 4 % and other losses (excluding dry gas loss) as 10 %. Specific heat of process fluid is 2500 J/kgK. Specific heat of CO_2, H_2O, O_2 and N_2 are 1.055, 2.014, 0.997 and 1.057 kJ/kg K respectively. Consider 55 % load in radiant section. Allowable maximum radiation heat flux is 30 kW/m^2. Tube diameter = 210 mm, pitch = 250 mm, H/D = 1.5. Find:

(a) Furnace efficiency (b) Radiant zone load

(c) Height and diameter of the furnace, (d) Number of tubes in radiant zone **05**

5B. In a cooling tower performance test, the following readings are noted in case of Forced mode.

Water entry temperature	=	45°C
Water exit temperature	=	40°C
WBT at entry	=	25°C
WBT at exit	=	30°C
DBT at entry	=	33°C
DBT at exit	=	37°C
Water flow rate	=	10 lpm
Duration of test	=	300 s

Find:

(a) Cooling tower duty

(b) Cooling tower efficiency

(c) Mass flow rate of air

(d) Rate of make-up water **05**