Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B. TECH (MECHANICAL/IP ENGG.) END SEMESTER MAKE UP EXAMINATIONS, DECEMBER 2018

SUBJECT: DESIGN OF THERMAL POWER PLANT SYSTEMS [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 neat sketches explain the difference between:
(a) Once through cooling and dry cooling
(b) Forced draught cooling and induced draught cooling **05**

1B. Find the length of the Shell and tube heat exchanger with following specifications:

Shell size	:	12″	Hot fluid	:	Treated water (5000 kg/h)
Number of	:	1	Cold fluid	:	Sea water (50000 kg/h)
Baffle spacing	:	0.25 m	Entry	:	Hot: 80°C / Cold: 38°C
			Exit temperature	:	Hot: 40°C / Cold: 42°C

Tube material : Carbon steel, AISI 1010
Tube configuration : ¾″ OD on 1″ square pitch (20 BWG)
Neglect effect of property variation at shell side. Also neglect fouling resistance. **05**

2A. With a neat sketch, explain the radiant and convective zones in furnace. What are the different losses (with percentage contribution) incurred in furnace. **05**

2B. Flue gas at 300°C with a velocity of 20 m/s flow across a compact heat exchanger of type 9.1-0.737-S. Water at 40°C and flow rate of 40 kg/s flows through the conduit. Frontal length and height for gas flow is 0.60 m x 0.50 m. Flow length is 0.40 m. Neglect wall resistance. Find rate of heat transfer.

Water side c/s porosity	:	0.15
Material	:	Al alloy 195
Height of the fin	:	1.5 mm
Water side area of core	:	150 m^2/m^3

05

3A. Explain with neat sketches the different models of film condensation in tube bundles. **05**

3B. The designed length of the DPHX is 24 m. However due to space constraint (2 m), hairpin configuration is suggested. If 3 hairpins are considered for each parallel flow stream, find the total HX length ratio between two cases. Case I- Hot fluid series

and Case II-Cold fluid series.

Inlet and outlet temperature of hot fluid : 100°C and 60°C

Inlet and outlet temperature of cold fluid : 30°C and 70°C **05**

4A. How tube or annulus side pressure drop can be reduced in case of double pipe heat exchangers? Explain with neat sketch. **05**

4B. A Condenser is to be designed to condense 145 kg/h of water at atmospheric pressure. A square array of 81, 12 mm outside diameter tubes are available for the design and the wall temperature of the tube maintained at 96°C.

(a) Estimate the length of the tube required (using Nusselt 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?

Properties of saturated water and steam are:

$\rho_l = 961 kg/m^3$ $k_l = 0.6804$ W/mK $\mu_l = 2.81 \times 10^{-4}$ Pa.s $h_{fg} = 2257$ kJ/kg **05**

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

Water entry temperature	=	45°C	DBT at entry	=	33°C
Water exit temperature	=	40°C	DBT at exit	=	37°C
WBT at entry	=	25°C	Water flow rate	=	10 lpm
WBT at exit	=	30°C	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**

5B. A furnace heater is designed for heat load of 10 MW. The process fluid has the transfer coefficient of 1000 W/m^2K. Tubes are 235 mm in diameter with 350 mm spacing and have the wall heat transfer coefficient of 2500 W/m^2K. Vertical cylinder heater have 5 rows of horizontal plain tubes each 2.5 m long in convection section. Overall efficiency of the heater is 85 %. Natural gas fuel (CH_4) is fired with 25 % excess air. Take the average flue gas temperature as 900 K and tube temperature as 280 K. Find the overall heat transfer coefficient of tubes in the convective section. **05**