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 2019

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 a neat sketch explain various heat exchangers present in the steam generation process. **05**

1B. 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**

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

2B. 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 pass	:	1	Cold fluid	:	Sea water (50000 kg/h)
Baffle spacing	:	0.25 m	Entry temperature	:	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**

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

3B. 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**

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 furnace heater is designed for heat load of 10 MW. The process fluid has the transfer coefficient of 1000 W/m^{2}K. Tubes are 235 mm in diameter with 350 mm spacing and have the wall heat transfer coefficient of 2500 W/m^{2}K. 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**

5A. In a cooling tower (forced mode) performance test, the following readings are noted :

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 condenser is to be designed to condense 200 kg/h of steam at atmospheric pressure. A square array of 144, 15 mm outside diameter tubes are available for the design and the wall temperature of the tube is maintained at 96°C.

(a) Estimate the length of the tube required (by referring 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? If so find the modified value. **05**