Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

END Semester Examination, March 2019

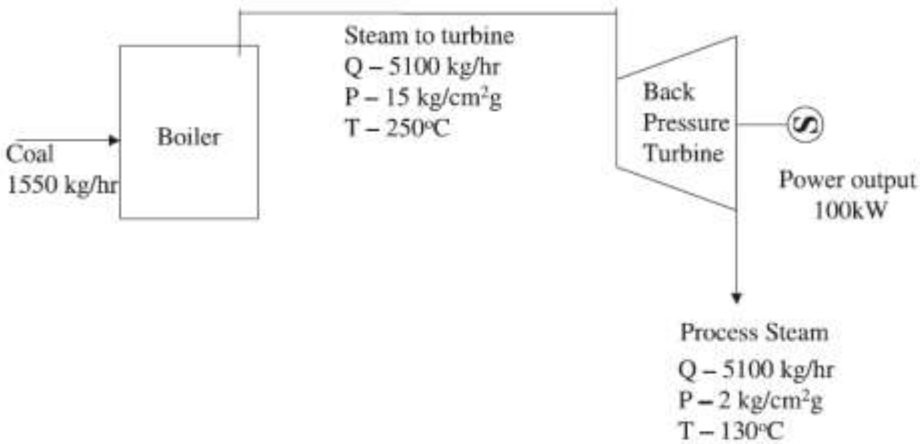
Programme Name: M. Tech Energy Systems | **Semester : II**
Course Name : Performance analysis of Thermal Equipment | **Time : 03 hrs**
Course Code : EPEC 8004 | **Max. Marks : 100**
Nos. of page(s) : 3

SECTION A

S. No.		Marks	CO
Q 1	Draw the schematic diagram of topping cycle cogeneration system.	**4**	**CO1**
Q 2	Illustrate the continuous and batch type reheating furnace.	**4**	**CO1**
Q 3	Explain why the term effectiveness rather than efficiency is used in the performance assessment of heat exchanger.	**4**	**CO2**
Q 4	In a sugar mill, a process requires 5000 kg/hr of dry saturated steam at 7 kg/cm2 (g). For the flow velocity not to exceed 25 m/s, determine the pipe diameter size for distribution of steam. Specific volume at 7 kg/cm2 = 0.24 m3/kg	**4**	**CO2**
Q 5	Discuss advantages of condensate and flash steam recovery in steam systems.	**4**	**CO1**

SECTION B

Q 6	The following are the data collected for a boiler using furnace oil as a fuel. Determine the boiler efficiency based on the GCV by indirect method. Ultimate analysis (wt%): carbon 84, hydrogen 12, nitrogen 0.5, oxygen 1.5, moisture 0.5, NCV of fuel 9763 kCal/kg and humidity 0.025 kg of moisture/kg of dry air. Flue gas analysis: CO2 9.8% by volume, flue gas exit temperature 190°C, and ambient temperature 30°C.	**10**	**CO2**
Q 7	The parameters for back pressure steam turbine cogeneration plant is given below. Inlet steam (1) p=16 kg/cm2, t= 310C, Q= 9000kg/hr. Outlet steam (2) p=5 kg/cm2, t=235C, Q=9000kg/hr. Calculate the turbine stage (isentropic) efficiency. H_1 = 798 kCal/kg, H_2 = 748 kCal/kg.	**10**	**CO3**
Q 8	Milk is flowing in a pipe cooler at a rate of 0.85 kg/sec. Initial temperature of the milk is 60°C and it is cooled to 22 °C using a stirred water bath with a constant temperature of 10°C around the pipe. Specific heat of milk is 3.86 KJ/kg°C. Calculate the heat transfer rate (kcal/hr) and also LMTD of the exchanger.	**10**	**CO3**
Q 9	The flow rates of the hot and cold-water streams flowing through a heat exchanger are 10 and 25 kg/min, hot and cold side inlet temperatures are 70 and 25°C respectively. The exit temperature of the hot side stream is required to be 50°C and overall heat transfer coefficient is 800 w/m^2. Calculate the heat transfer area of parallel flow and counter flow heat exchanger.	**10**	**CO3**

	(OR) A distillery plant having an average production of 40 kilolitres of ethanol is having a cogeneration system with a backpressure turbine. The plant steam and electrical demand are 5.1 Tons/hr and 100 kW. The process flow diagram is shown in figure. Gross calorific value of Indian coal is 4000 kCal/kg. h_s = 698 kCal/kg, h_p = 648 kCal/kg. Efficiency of the turbo alternator = 34%, Efficiency of Alternator = 92 %, Efficiency of gear transmission = 98 %. Calculate • Turbine cylinder efficiency. • Overall plant heat rate. 		

SECTION-C

Q 10	Paddy husk is being used as a combustion fuel in a water tube boiler. The ultimate analysis of fuel is given below. Calculate theoretical amount of air required per 100 kg of husk for the combustion from the following data. Ultimate Analysis of Typical paddy husk: Moisture 11.8%, Mineral Matter 17.7%, Carbon 32.0%, Hydrogen 5.0%, Nitrogen 0.9%, Sulphur 0.1%, Oxygen 32.5%.	**20**	**CO4**
Q 11	A shell and tube exchanger of following configuration is considered being used for oil cooler with oil at the shell side and cooling water at the tube side. Tube Side • 460 Nos x 25.4mmOD x 2.11mm thick x 7211mm long • Pitch - 31.75mm 30° triangular • 2 Pass. Shell Side • 787 mm ID • Baffle space - 787 mm • 1 Pass.	**20**	**CO4**

Parameters	Inlet	Outlet
Hot fluid flow (kg/h)	719800	719800
Cold fluid flow (kg/h)	881150	881150
Hot fluid temp C	145	102
Cold fluid flow C	25.5	49
Hot fluid pressure (bar, g)	4.1	2.8
Cold fluid pressure (bar,g)	6.2	5.1

Heat transfer area = 264.55 m^2. Calculate overall heat transfer coefficient.

	(OR) An oil-fired reheating furnace has an operating temperature of around 1340°C. Average fuel consumption is 400 litres/hour. The flue gas exit temperature after air preheater is 750°C. Air is preheated from ambient temperature of 40°C to 190°C through an air pre-heater. The furnace has 460 mm thick wall (x) on the billet extraction outlet side, which is 1 m high (D) and 1 m wide. The other data are as given below. Calculate the efficiency of the furnace by both indirect and direct method. Specific gravity of oil = 0.92, Calorific value of oil = 10000 kCal/kg, Average O2 percentage in flue gas = 12%, Weight of stock = 6000 kg/hr, Specific heat of Billet = 0.12 kCal/kg/°C, Surface temperature of roof and side walls = 122 °C Surface temperature other than heating and soaking zone = 85 °C, oxygen in flue gas = 12%, Black body radiation corresponding to 1340°C = 36.00 kCal/cm2 /hr, Emissivity = 0.8, The factor of radiation = 0.71. Assume the appropriate data wherever required.		

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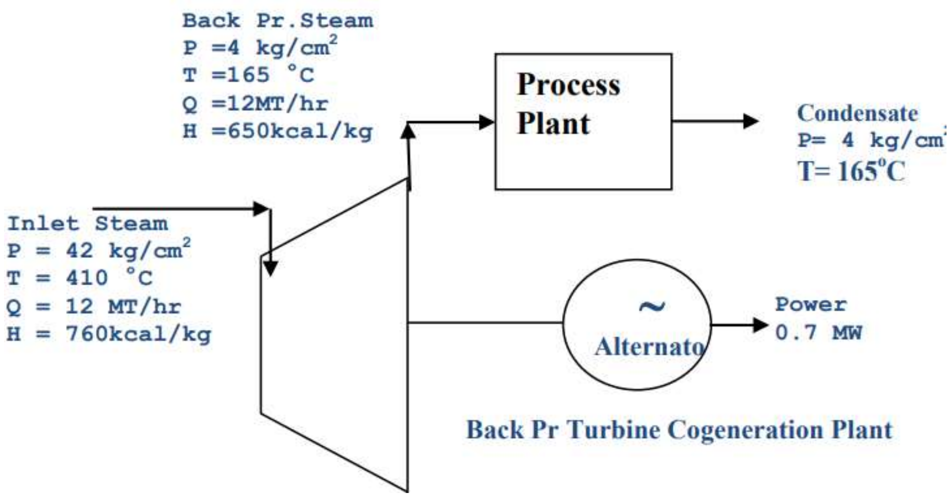
SECTION A

S. No.		Marks	CO
Q 1	List down any five good practices in Furnaces for energy efficiency.	**4**	**CO1**
Q 2	Illustrate the continuous type reheating furnace with schematic diagram.	**4**	**CO1**
Q 3	discuss the term effectiveness and efficiency in the performance assessment of heat exchanger.	**4**	**CO2**
Q 4	In a paper mill, a process requires 1000 kg/hr of dry saturated steam at 5 kg/cm2 (g). For the flow velocity not to exceed 30 m/s, determine the pipe diameter size for distribution of steam. Specific volume at 5 kg/cm2 = 0.21 m3/kg	**4**	**CO2**
Q 5	Explain the condensate and flash steam recovery in steam systems.	**4**	**CO1**

SECTION B

Q 6	The following are the data collected for a generator using furnace oil as a fuel. Determine the generator efficiency based on the GCV by indirect method. Ultimate analysis (wt%): carbon 84, hydrogen 12, nitrogen 0.5, oxygen 1.5, moisture 0.5, NCV of fuel 9763 kCal/kg and humidity 0.025 kg of moisture/kg of dry air. Flue gas analysis: CO2 9.8% by volume, flue gas exit temperature 150°C, and ambient temperature 30°C.	**10**	**CO2**
Q 7	Calculate the electricity consumption in an induction melting furnace from the following melt cycle data. Mild steel (MS) scrap charged: 1250 kg, Specific heat of MS : 0.68 kJ/kgC, Latent heat of MS : 270 kJ/kg, MS melting temperature : 1450 C Inlet MS charge temperature : 35 C Efficiency of furnace : 70%.	**10**	**CO3**
Q 8	Milk is flowing in a pipe cooler at a rate of 0.95 kg/sec. Initial temperature of the milk is 55 °C and it is cooled to 18 °C using a stirred water bath with the constant temperature of 10°C around the pipe. Specific heat of milk is 3.86 KJ/kg°C. Calculate the heat transfer rate (kcal/hr) and also LMTD of the exchanger.	**10**	**CO3**
Q 9	The flow rates of the hot and cold-water streams flowing through a heat exchanger are 10 and 25 kg/min, hot and cold side inlet temperatures are 70 and 25°C respectively. The exit temperature of the hot side stream is required to be 50°C and overall heat transfer coefficient is 800 w/m^2. Calculate the heat transfer area of parallel flow and counter flow heat exchanger.	**10**	**CO3**

	(OR) Determine the Energy Utilization Factor (EUF) from the following back pressure cogeneration plant diagram and data given. 		
SECTION-C			
Q 10	Rice husk is being used as a combustion fuel in a water tube boiler. The ultimate analysis of fuel is given below. Calculate theoretical amount of air required per 100 kg of husk for the combustion from the following data. Ultimate Analysis of Typical Rice husk: Moisture 12.8%, Mineral Matter 18.7%, Carbon 33.0%, Hydrogen 4.0%, Nitrogen 0.8%, Sulphur 0.2%, Oxygen 32.5%.	**20**	**CO4**
Q 11	A liquid waste stream has a flow rate of 3.5 kg/s and a temperature of 70 C with a specific heat capacity of 4190 J/kgK. Heat recovered from the hot waste stream is used to pre-heat boiler make-up water. The flow rate of the make-up water is 2 kg/s, its temperature is 10 C and its specific heat capacity is 4190 J/kg/K. The overall heat transfer coefficient of the heat exchanger is 800 W/m2 K. If a make-up water exit temperature of 50 C is required, and assuming that there is no heat losses from the exchanger, determine i) The heat transfer rate ii) The exit temperature of the effluent and iii) The area of the heat exchanger required **(OR)** An oil-fired reheating furnace has an operating temperature of around 1340°C. Average fuel consumption is 400 litres/hour. The flue gas exit temperature after air preheater is 750°C. Air is preheated from ambient temperature of 40°C to 190°C through an air pre-heater. The furnace has 460 mm thick wall (x) on the billet extraction outlet side, which is 1 m high (D) and 1 m wide. The other data are as given below. Calculate the efficiency of the furnace by both indirect and direct	**20**	**CO4**

	method. Specific gravity of oil = 0.92, Calorific value of oil = 10000 kCal/kg, Average O2 percentage in flue gas = 12%, Weight of stock = 6000 kg/hr, Specific heat of Billet = 0.12 kCal/kg/°C, Surface temperature of roof and side walls = 122 °C Surface temperature other than heating and soaking zone = 85 °C, oxygen in flue gas = 12%, Black body radiation corresponding to 1340°C = 36.00 kCal/cm2 /hr, Emissivity = 0.8, The factor of radiation = 0.71. Assume the appropriate data wherever required.		