Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: Waste Heat Recovery & Cogeneration **Semester: 7th**
Programme: B. Tech (ET+IPR)
Time: 03 hrs. **Max. Marks: 100**
Instructions:

SECTION A

S. No.		Marks	CO
Q 1	Elaborate on the opportunities where VAM (Vapor Absorption Machines) find best applications.	**5**	**CO2**
Q 2	A domestic food refrigerator maintains a temperature of -100C. The ambient air temperature is 400C. If heat leaks into the freezer at a continuous rate of 2 kJ/s, determine the least power necessary to pump this heat out continuously.	**5**	**CO1**
Q 3	Draw a schematic diagram of a combined cycle power plant.	**5**	**CO3**
Q 4	In a heat exchanger, the hot stream enters at 70^{O}C and leaves at 55^{O}C. On the other side, the cold stream enters at 30^{O}C and leaves at 55^{O}C. Determine the LMTD of the heat exchanger.	**5**	**CO3**
	SECTION B		
Q 5	Mention the features of waste heat recovery for refineries, and in that context provide a conceptual diagram of where such can be implemented.	**10**	**CO4**
Q 6	Enumerate the various benefits of waste heat utilization for industries. What types of industries are more likely to go with such installations? Or, Explain typical applications of waste heat boilers. In lieu of what parameters do they differ from ordinary steam boilers? In what temp. range do they operate? Is it more energy efficient to generate hot water of 800C or saturated steam at 6 bar in a waste heat boiler? Explain	**10**	**CO5** **CO5**
Q 7	Explain how increasing the "**Use of tri-generation based Energy efficient cooling technologies can help reduce power shortages in India and decrease GHG emissions.**" *You may use a case study to elaborate on the aforementioned topic.*	**10**	**CO6**

Q 8	With the help of a neat diagram show the various heat and waste heat sources in a cement industry. Also explain the implementation of Cement WHR based CPP schematic, and justify it to be economical.	**10**	**CO6**
	SECTION-C		
Q 10	There are two alternative sources of heat energy. Source 1 can supply energy at the rate of 10,000 kJ/min at 320^0C. Source 2 can apply energy at the rate of 120,000 kJ/min at 65^0C. If an ideal reversible engine is used to produce power, which source out of these two will provide larger power if the temperature of the surroundings is 35^0C ?	**20**	**CO5**
Q 11	Hot oil is to be cooled in a double-tube counter-flow heat exchanger. The copper inner tubes have a diameter of 2 cm and negligible thickness. The inner diameter of the outer tube (the shell) is 3 cm. Water flows through the tube at a rate of 0.5 kg/s, and the oil through the shell at a rate of 0.8 kg/s. Taking the average temperatures of the water and the oil to be 45°C and 80°C, respectively, determine the overall heat transfer coefficient of this heat exchanger. ρ = 990 kg/m3, Pr = 3.91, k = 0.637 W/m · °C, $\nu = \mu/\rho$ = 0.602 x10 -6 m2/s. Or, Give a brief account of the integration of Vapor absorption machines with gas turbine power plant, or a gas turbine cogeneration plant. Provide suitable process diagram for it. What are the advantages with such installations? Sketch the schematic of 'Back Pressure Turbine' and 'Extraction Condensing Turbine' cogeneration system.	**20**	**CO6** **CO6**

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Name of the School (Please tick, symbol is given)	:	**SOE**	✓	**SOCS**		**SOP**	
Programme	:	**Waste Heat Recovery & Cogeneration**					
Semester	:	**7th**					
Name of the Course	:	**B. Tech (ET+IPR)**					
Course Code	:	**ETEG 411**					
Name of Question Paper Setter	:	**Surajit Mondal**					
Employee Code	:	**40001394**					
Mobile & Extension	:	**9690133458**					
Note: Please mention additional Stationery to be provided, during examination such as Table/Graph Sheet etc. else mention "NOT APPLICABLE":							

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Note: - Pl. start your question paper from next page

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SECTION A

S. No.		Marks	CO
Q 1	Comment on the waste heat recovery options for a sulfur recovery plant, and provide a conceptual diagram for where such can be implemented.	**5**	**CO1**
Q 2	Elaborate on the various "thermal sources" that can be utilized by absorption chillers.	**5**	**CO2**
Q 3	Give a brief account of the implications for using absorption chillers in Sugar Industries.	**5**	**CO2**
Q 4	Comment on the importance of "Solar Thermal Air conditioning system" and how it affects process optimization.	**5**	**CO3**
	SECTION B		
Q 5	Explain how Solar Thermal AC systems work. With the help of a neat process diagram show how the process can be installed using absorption machines.	**10**	**CO4**
Q 6	Mention the various "Low Pressure" and "Medium Pressure" Thermal sources that can be considered for process cooling using VAMs. Or, Explain with a neat diagram about **'Shell and Tube Heat Exchange'**. Discuss the types of Recuperators? Explain any one of them with a neat sketch.	**10**	**CO2** **CO2**
Q 7	With the help of a process flow diagram explain how solar thermal systems can be integrated with Vapor Absorption Machine to provide process cooling. Has this process been successfully implemented in India? Comment.	**10**	**CO4**
Q 8	Sketch the schematic of 'Back Pressure Turbine' and 'Extraction Condensing Turbine' cogeneration system.	**10**	**CO6**

SECTION-C			
Q 10	(A) The operating temperatures of a single stage vapour absorption refrigeration system are generator: 90^oC; condenser and absorber: 40^0C; evaporator: 0^0C. The system has a refrigeration capacity of 100 kW and the heat input to the system is 160 kW. The solution pump work is negligible. a) Find the COP of the system and the total heat rejection rate from the system. b) An inventor claims that by improving the design of all the components of the system he could reduce the heat input to the system to 80 kW while keeping the refrigeration capacity and operating temperatures same as before. Examine the validity of the claim. (B) Calculate the fuel oil savings by providing an Economiser for a boiler. The performance data of the boiler are given as below: • Average quantity of steam generated : 5 T/h • Average flue gas temperature : 315^oC (without economiser) • Average steam generation / kg of fuel oil : 14 kg • Feed water inlet temperature : 110^oC • Fuel oil supply rate : 314 kg/h • Flue gas quantity : 17.4 kg/kg of fuel • Gross calorific value of fuel : 10,000 kCal/kg • Rise in feed water temperature by providing economizer: 26°C • Annual operating hours : 8600	**20**	**CO5**
Q 11	A 2-shell passes and 4-tube passes heat exchanger is used to heat glycerin from 20°C to 50°C by hot water, which enters the thin-walled 2cm diameter tubes at 80°C and leaves at 40°C. The total length of the tubes in the heat exchanger is 60 m. The convection heat transfer coefficient is 25 W/m2 °C on the glycerin (shell) side and 160 W/m2 °C on the water (tube) side. Determine the rate of heat transfer in the heat exchanger (a) before any fouling occurs and (b) after fouling with a fouling factor of 0.0006 m2 °C/W occurs on the outer surfaces of the tubes. Or, Explain the term 'Trigeneration'? Enumerate the various site selection criteria for it. Using block diagram representation, explain how trigeneration works and where it finds applicability. Explain briefly with a neat sketch the operation of a Regenerator for WHR.	**20**	**CO6** **CO6**