Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Course: Waste Heat Recovery & Cogeneration **Semester: VII**
Program: B tech ET+IPR **Time 03 hrs.**
Course Code: ETEG411 **Max. Marks: 100**

Instructions: Read the question paper carefully before answering, Section B and C has one internal choice.

SECTION A

S. No.		Marks	CO
Q 1	What are the designs available for recuperators? Explain with neat diagram	**4**	**CO1**
Q 2	Using line diagram, show any two sources for heat and two sources for waste heat in the Cement Industry.	**4**	**CO3**
Q 3	What are absorption chillers? In addition, why are they intrinsic to the WHR units?	**4**	**CO4**
Q 4	Enumerate the various site selection criteria Trigeneration, and where it finds applicability.	**4**	**CO5**
Q 5	Explain why the Brayton cycle and the Rankine cycle while working together recovers more energy from fuel than either cycles working independently.	**4**	**CO2**
	SECTION B		
Q 6	Graphically show the concepts of "Power First" and "Heat First" economics. Further, explain the implications for the same in terms of Capital cost, operating cost, and Environmental aspects.	**10**	**CO2**
Q 7	A double pipe heat exchanger is used to cool a hot stream from 177° C to 121° C by heating a cold stream from 77° C to 49° C. The hot stream will flow in the inner pipe in a counter flow arrangement to the cold stream in the outer pipe. The heat transfer surface area of 18.5 m^2 will transfer the heat load of 1025.85 kW. Determine the overall heat transfer co-efficient (U).	**10**	**CO4**
Q 8	Comment on the working of **Triple effect Vapor absorption Machines** with the help of a neat flow diagram. How hybrid systems can be integrated into this? Enlist the limitations of such systems. **OR**	**10**	**CO5**

<table>
<tr><td></td><td>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?</td><td></td><td></td></tr>
<tr><td>Q 9</td><td>Determine the air fuel ratio and specific energy consumption of mill from the following data

Coal air flow rate: 48.64 TPH
Air flow rate: 112.6 TPH
Energy Consumption: 351 kW

Additionally explain the significance of air fuel ratio, and the role of WHR devices in air preheating.</td><td>10</td><td>CO3</td></tr>
<tr><td colspan="4">SECTION-C</td></tr>
<tr><td>Q 10</td><td>The following is data for a cogeneration plant with a Steam Turbine. The plant requires 4.5 MW of Electrical Power.

<table>
<tr><th>Process</th><th>Steam Flow (TPH)</th><th>Pressure (kg/cm^2)</th><th>Temperature (°C)</th><th>Enthalpy (Kcal/kg)</th></tr>
<tr><td>Boiler</td><td>31.25</td><td>62</td><td>486</td><td>808</td></tr>
<tr><td>Process-I</td><td>3.25</td><td>20</td><td>310</td><td>669</td></tr>
<tr><td>Process-II</td><td>8.00</td><td>7</td><td>174</td><td>662</td></tr>
<tr><td>Process-III</td><td>20.0</td><td>4</td><td>160</td><td>659</td></tr>
</table>

Draw a block diagram depicting the process with necessary heat balance parameters.

Additional Data Given: Alternator efficiency = 95%, Transmission efficiency = 95%, Stage (Isentropic) efficiency = 84.2%, Mechanical efficiency of the turbine = 95%.

Efficiency of the boiler is 78% with enthalpy for Feed water at 60 KCal/kg.

The fuel is coal with average GCV = 4000 KCal/kg.

Calculate the following:
(a) The total power that could be generated by the Turbine.
(b) Additional power to be purchased from Grid.
(c) Heat to power ratio for the Cogeneration Plant.</td><td>20</td><td>CO5</td></tr>
</table>

	(d) Hourly Fuel Consumption rate in TPH. (e) Energy Utilization Factor (EUF) of the Cogeneration Plant.		
Q 11	Construct a neatly labelled flow diagram showing the process flow for integrating VAM with Gas Turbines. Also, explain the relative advantages and applications of the system. **OR** Explain how the vapor absorption cycle works, with elaboration on the parts and process involved for the same. What is the significance of the help of absorbent and refrigerant in context to the above-mentioned cycle?	**20**	**CO4**