Name: **Enrolment No:**	UPES

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

Course: Thermal Utilities [EPEC7027] **Semester: I**
Program: M tech Energy Systems [ES]
Time: 03 hrs. **Max. Marks: 100**
Instructions: Attempt all questions Section-wise, internal choice is given for Section B and Section C

SECTION A

S. No.		Marks	CO
Q 1	What do you understand by Auxiliary Energy Consumption? Elaborate on Gross Heat Rate (GHR) and Net Heat Rate (NHR) in the context of Thermal Power Plants.	**4**	**CO3**
Q 2	Elaborate on the various challenges in Furnace Design, and how the same can be addressed by energy intensive industries.	**4**	**CO2**
Q 3	Describe the various benefits associated with Thermal Insulation for industrial processes, and further classify insulation materials based on temperature profiles.	**4**	**CO3**
Q 4	Why Hydrogen is considered a fuel for the future? Enlist the areas it can been a suitable substitute in the Power and Energy Infrastructure.	**4**	**CO4**
Q 5	Enumerate four energy efficiency opportunities for Boilers in Power Plant Operation.	**4**	**CO1**
	SECTION B		
Q 6	A boiler is provided with a chimney of 26m height. The air temperature at boiler house inlet is 30°C and temperature of flue gases leaving chimney is 300°C. If air supplied to the boiler is 20kg/kg of fuel. Estimate: (i) Draught in mm of water, (ii) Velocity of gases passing through chimney with 50% loss of draught in Chimney.	**10**	**CO2**
Q 7	Explain Rankine Cycle with Regeneration, with the help of a neat process diagram, and T-S plot, further elaborate on why the cycle is called Regenerative and the advantages associated with this system.	**10**	**CO1**
Q 8	Elaborate on the various criteria for selecting a Refractory Material, and further explain the significance of Pyrometric Cone Equivalence. In the above context, explain the volume stability issues associated with such systems.	**10**	**CO3**

Q 9	A practical OTTO cycle engine has an efficiency of, say, 20%, while a practical methanol fuel cell may have an efficiency of 60% (this is the efficiency of the practical cell compared with that of the ideal cell). If a methanol fueled IC car has a highway performance of 10 km per liter, what is the performance of the fuel cell car assuming that all the other characteristics of the cars are identical. If you drive 2000 km per month and a gallon of methanol costs $2.40, how much do you save in fuel per year when you use the fuel cell version compared with the IC version? **OR** With the help of a neat process diagram, Explain the working of Coal based Magneto-hydrodynamic (MHD) systems. Further, elaborate the role of diffuser and its significance during system operation.	**10**	**CO4**
	SECTION-C		
Q 11	Determine height and diameter of chimney to produce static draught of 18 mm of water column if mean flue gas temperature and flow rate are 300C and 2100 kg/min respectively, the atmospheric air temperature is 25 C. The gas constant for air is 287 KJ/Kg-K and for flue gas 250KJ/Kg-K. Assume no loss of draught in chimney and barometer reading is 760 mm of mercury. **Stoichiometric Correlations to be used:** 760 mm of Hg = 1.01325 bar = 1.01325×10^5 KJ/kg $\rho_{g=\left(\frac{m_a+1}{m_a}\right)\frac{353}{T_g}}$ PV = nRT (Ideal Gas Equation) $H_1 = H\left[\left(\frac{m_a}{m_a+1}\right)\frac{T_g}{T_a}-1\right]$	**20**	**CO3**
Q 12	What do you understand by Energy Storage? Explain the working of Battery Storage systems and how it is critical to balance Power Plant Operations. In that context, explain how Demand Side Management (DSM) can be linked with such systems. **OR** What do you mean by a mechanical stoker? In that context, explain the working of Spreader Stoker Boiler with the help of a neat flow diagram. Further, keeping the above in mind, elaborate on DSM measures applied to Steam Boilers.	**20**	**CO5**

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Name of the School (Please tick, symbol is given)	:	**SOE**	☐	**SOCS**		**SOP**	
Programme	:	**M Tech Energy Systems (ES)**					
Semester	:	**I**					
Name of the Course	:	**Thermal Utilities**					
Course Code	:	**EPEC7027**					
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Note: Please mention additional Stationery to be provided, during examination such as Table/Graph Sheet etc. else mention "NOT APPLICABLE":							

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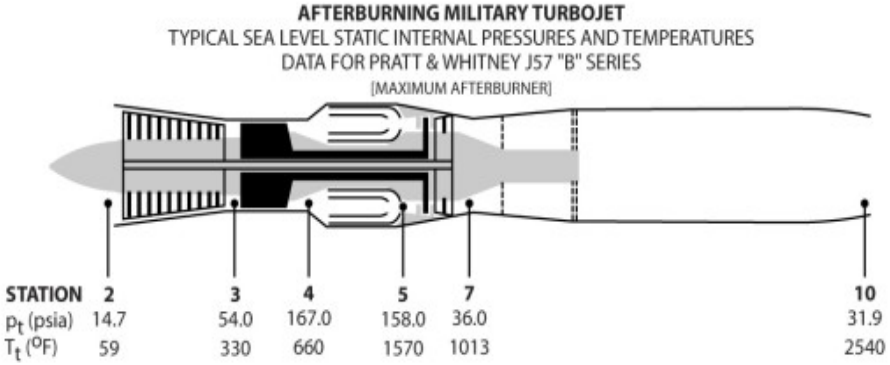
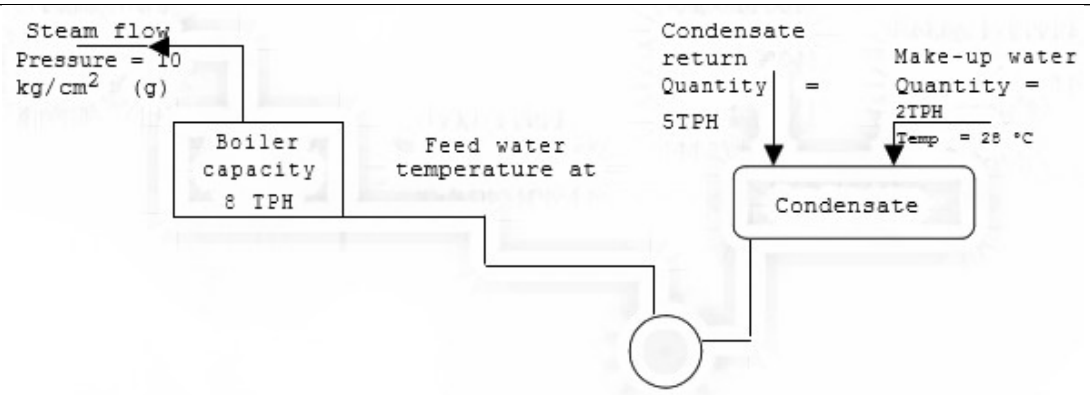
SECTION A

S. No.		Marks	CO
Q 1	Elaborate on the various classification of Furnaces. Provide one example for classification based on type of heat source and heat sink.	**4**	**CO2**
Q 2	Discuss "Economic Thickness of Insulation" and mention its significance to power plant operations.	**4**	**CO3**
Q 3	Enlist the differences between Water Tube Boilers and Fire Tube Boilers with simple concept diagrams.	**4**	**CO1**
Q 4	What are the various aspects of Fuel Cell Technology that makes them an attractive alternative to fossil fuel based energy?	**4**	**CO4**
Q 5	Enumerate any four general fuel economy measures in Furnaces for Power Plant Operations.	**4**	**CO2**
	SECTION B		
Q 6	With the help of T-S plot and a neat process diagram, explain Rankine Cycle with Reheat, and what are the several advantages associated with the process?	**10**	**CO1**
Q 7	A domestic fuel cell system in a rural area is to be fed by butane. This gas is to be steam reformed and the resulting carbon monoxide is to be shifted to hydrogen. Assuming no losses, how many kg of hydrogen can be extracted from each kg of butane? Also calculate percentage yield for hydrogen.	**10**	**CO4**
Q 8	Perform a feasibility analysis between an oil fired boiler and a coal fired boiler having steam production capacity of 10 TPH. Heat content of steam at boiler outlet is 660 kCal/kg, with inlet enthalpy at 60 kCal/kg. Consider an annual operation of 24 hours 300 days a year. Given oil fired boiler efficiency is 82%, and for the coal fired boiler 72%. The cost of oil and coal are US $300/ton and US $45/ton respectively. Additionally, the GCV of oil is 10, 000 kCal/kg and that of coal is 4200 kCal/kg. With the help of given data compute, the following: **a. Annual consumption of oil in Tons per Year.** **b. Annual consumption of coal in Tons per year.** **c. Annual fuel cost saving in US $.**	**10**	**CO1**

Q 9	Draught produced by chimney is 2 cm of water column. Temperature of flue gas is 300°C and ambient temperature is 33°C. The flue gas formed per kg of fuel burnt is 24 kg. Neglect the losses and take the diameter of chimney as 1.75 m. Calculate: **a. Height of Chimney in meters.** **b. Mass of flue gas flowing through the chimney in kg/min.** Density of flue gases is given by: $\rho_{g=}\left(\frac{m_a+1}{m_a}\right)\frac{353}{T_g}$ **OR** Comment on Performance Evaluation for Furnaces, and elaborate on the major heat losses from a furnace, during a process operation. Use a neatly labelled concept diagram to explain the heat losses.	**10**	**CO3**
	SECTION-C		
Q 10	Consider an aircraft in level flight. The rate of change of the gross weight of the vehicle is equal to the fuel weight flow.  For the given figure evaluate the following: a. The Propulsion Energy Conversion Chain. b. Operation of the Gas Turbine engine with block diagram. c. Operation of Gas Turbines with block diagram as applied to Thermal Power Generation Utilities. d. The concept of Combined Cycle Power Plant as applied to Thermal Power Stations.	**20**	**CO5**
Q 11	Analyze the diagram given below and answer the question.	**20**	**CO4**



Data Given:
Enthalpy of steam (dry & saturated) at 10 kg/cm2 (g) pressure: 665 kcal/kg
Furnace oil consumption: 600 liters
Specific gravity of furnace oil: 0.89
Calorific value of FO (GCV): 9650 Kcal/ kg

a. Calculate the boiler efficiency by direct method.
b. Calculate the water temperature in the condensate tank.
c. Estimate the fuel loss due to drop in feed water temperature

OR

What do you understand by Compressed Air Energy Storage (CAES)? Present a case study with neatly labelled concept diagram for the 100 MWe Compressed Air Energy Storage Plant, run by Alabama Electric Corp. in the US.

In the above context, analyze the following:

a. Advantages of CAES Power Stations.
b. Limitations of CAES Power Stations.