Name:

Enrolment No:

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

Course: Thermal Utilities **Semester: VII**
Program: B tech ET +IPR
Time: 03 hrs. **Max. Marks: 100**
Instructions: Attempt all questions Section-wise, internal choice is given for Section B and Section C

SECTION A

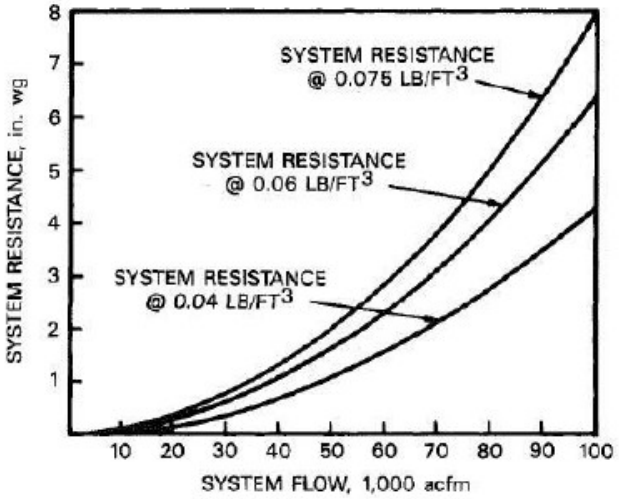
S. No.		Marks	CO
Q 1	Elaborate on the applications of Exergy analysis and the three pillars on which it stands.	**4**	**CO1**
Q 2	What do you understand by Draft systems? Explain its importance in the context of Thermal Power Plant Operations.	**4**	**CO2**
Q 3	Contrast and compare the operations of Impulse Turbine and Reaction Turbine with the help of a simple concept diagram.	**4**	**CO4**
Q 4	What do you understand by Organic Rankine Cycle? Elaborate on some application areas for the same.	**4**	**CO3**
Q 5	Enumerate the various advantages of heating water before feeding it back to the boiler.	**4**	**CO1**

SECTION B

Q 6	An induced draft system consists of the steam generator, air heater, electrostatic precipitator, wet scrubber, chimney, and the interconnecting ductwork. Flue gas from the steam generator leaves the common air heater outlet plenum and flows to two parallel electrostatic precipitators and four parallel wet scrubber modules.	**10**	**CO2**

Component	**Flue gas flow rate, 1,000 lb/h**	**Total pressure loss, in. wg**
Steam generator	5,000	8
Air heater	5,000	6
Precipitator, each	2,500	2
Wet scrubber, per module	1,750	5
Chimney	5,000	2
		Total 23

How does this total system resistance change if one precipitator and one scrubber module are removed from service and the total system flow at 5,000,000 lb/h is held constant?

Q 7	A duct system with multiple elbows, dampers, sudden enlargements, and contractions has been tested to have a system resistance of 2 in. of water gauge (in. wg) when the flow through the system is 50,000 actual cubic feet per minute (acfm) and the gas density is 0.075 lb/ft^3.  How does this system resistance change as the flow rate changes from 50,000 to 75,000 acfm with gas densities of 0.075 and 0.06 lb/ft^3?	**10**	**CO2**
Q 8	Enumerate the importance of Water Treatment in Thermal Power Plants and in that respect explain the process of Ion Exchange demineralization.	**10**	**CO4**
Q 9	What do you understand by the term "Auxiliary Energy Consumption" and "Plant Load Factor?" Construct a process flow diagram for Regenerative Rankine cycle with T-S plot for **six** extraction points. Comment on why the cycle is called "**Regenerative**." **OR** The production capacity of a paper drying machine is 500 TPD and is currently operating at an output of 480 TPD. To find out the steam requirement for drying, the Energy Manager measures the dryness of the paper both at inlet and outlet of the paper drying machine, and are found to be 60% and 95% respectively. The steam is supplied at 3.5 kg/cm^2, having a latent heat of 513 kCal/kg. The evaporated moisture temperature is around 100 ^{0}C having enthalpy of 640 kCal/kg. A. Estimate the quantity of moisture to be evaporated/hr. B. Input steam quantity required for evaporation per hour.	**10**	**CO3**

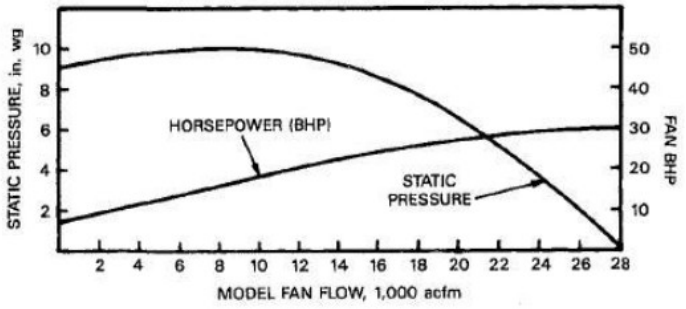
SECTION-C

Q 10

Convert model fan (b) performance to that of a full-size fan (a) with different speed and operating temperature as indicated below. Assume that the inlet pressure and gas molecular weight are the same for the model and full size fan.

Parameter	Model Fan (b)	Full size Fan (a)
Diameter, inches	20	80
RPM	1200	900
Temperature	60°F (520°R)	320°F (780°R)

The model fan performance curve is shown in the following figure:



The model fan performance data is given as:

Flow (acfm)	ΔP, in w.g.	bhp
3000	9	7
6000	10	16
12000	8.6	25
18000	5.2	28
24000	3.1	30

20 **CO2**

Q 11

"The share of renewable energy from wind, water and sun will increase further but these sources are not suited to cover the electrical base load due to their irregular availability. The combination of these sources, however, to produce hydrogen in co-operation with fuel cells may well be an option for future power generation."

In the above context explain the following in relation to role of Fuel Cells:

a. Stationary Power.
b. Propulsion of vehicles
c. Portable applications**.**

OR

With the help of a neat process diagram explain the working of Chain Grate or Travelling Grate Stoker, and further explain the design issues with the system, and how the heat losses, and other system limitations can be addressed.

20 **CO5**

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Programme	:	**B Tech ET + IPR**					
Semester	:	**VII**					
Name of the Course	:	**Thermal Utilities**					
Course Code	:	**PSEG337**					
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SECTION A

S. No.		Marks	CO
Q 1	Elaborate on how coal is pulverized in a CHP; also mention the mills that are used to achieve this operation.	**4**	**CO1**
Q 2	What is meant by Dead State? Differentiate between exergy analysis and energy analysis.	**4**	**CO2**
Q 3	Explain the process of power generation from a Gas Turbine, from fuel injection to production of electricity from the Generator.	**4**	**CO4**
Q 4	What are the various advantages and limitations associated with Natural Draught systems?	**4**	**CO3**
Q 5	Explain why Artificial Draught is more important in thermal power plant operation as compared to Natural Draught.	**4**	**CO1**

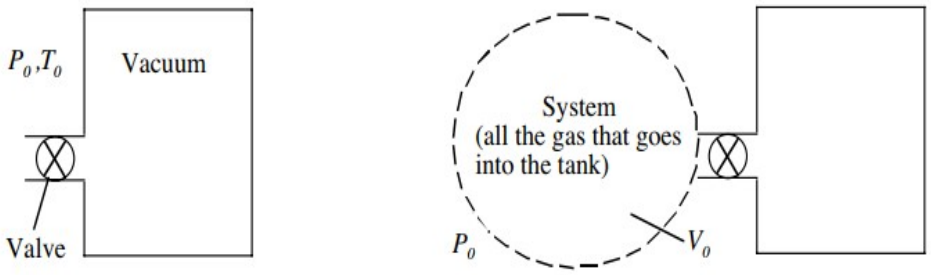
SECTION B

Q 6	A combustion air system consists of the following equipment, each component operating at its respective temperatures and pressure drops with a forced draft (FD) fan flow of 500,000 acfm:	**10**	**CO2**

Parameter	**Entering Temp. (°F)**	**Leaving Temp. (°F)**	**ΔP , in. wg**
FD fan inlet silencer	100	100	0.5
Ducts to air heater	110	110	0.5
Air heater	110	700	5.0
Ducts to wind box	700	700	1.0
Wind box dampers	700	700	2.0
Burners	700	700	4.0
			13.0 (Total)

How does this system resistance change with a 60° F ambient temperature reduction?

Q 7	A duct system with multiple elbows, dampers, sudden enlargements, and contractions has been tested to have a system resistance of 2 in. of water gauge (in. wg) when the flow through the system is 50,000 actual cubic feet per minute (acfm)	**10**	**CO2**

	and the gas density is 0.075 lb/ft^3. How does this system resistance change as the flow rate changes from 50,000 to 75,000 acfm with gas densities of 0.075 and 0.06 lb/ft^3?		
Q 8	What is the Indian Boiler Regulation? Elaborate on the topic. In that context, also explain IBR Steam Boilers and IBR Steam pipes.	**10**	**CO3**
Q 9	Explain the working of **Spreader Stoker Boiler** with a neat flow diagram. Also explain why such systems are preferred over other types of stokers in Industrial applications. **OR** A boiler system is to be controlled so the total dissolved solids in the blowdown does not exceed TDS_{BD} = 2000 mg/l for a feed water (makeup) that has TDS_F = 200 mg/l TDS. Steam consumption, Q_s is 1000 kg/day. Calculate Boiler Blowdown.	**10**	**CO3**
	SECTION-C		
Q 10	A. State the importance of "degasifiers" in the ion exchange process. With the help of neat diagrams, explain when a vacuum degasifier is used and when Forced draft systems are used.	**10**	**CO4**
	B. With reference to fly ash and bottom ash, explain the working of ash handling systems in Thermal Power Plants with a process flow diagram. Also, enlist the EPA standards for ash disposal.	**10**	**CO5**
Q 11	Consider a transient process of filling a tank, initially evacuated, from a surrounding atmosphere, which is at a pressure P_0 and a temperature T_0. The configuration is shown in the figure below:  At a given time, the valve at the tank inlet is opened and the outside air rushes in. The inflow stops when the pressure inside is equal to the pressure outside. The tank is	**20**	**CO1**

	insulated, so there is no heat transfer to the atmosphere. What is the final temperature of the gas in the tank? Assume ambient temperature of 30 °C. **OR** A 1000 MWe power plant is being planned for the rapidly expanding city of Las Vegas. Consider two possible options for the plant: coal and solar fueled. The total system should have a capacity factor of 90%. Answer the following questions. A. If the plant is to be of an advanced pulverized coal fired plant with a supercritical water-steam Rankine cycle, what is the average daily amount of coal (in kg/day) consumed to power the plant? Assume the combustion of 1kg of coal provides 27,800 Btu of energy (this is an average value; the real heat of combustion varies with the type of coal). 1J = 9.48×10^{-4} Btu = 0.239 cal. B. If an advanced solar photovoltaic plant is to be used, with the best available solar flux-to-electricity conversion efficiency of 12%, what is the total land area required to provide the needed power? You may assume that the land needed is 2 times the flat panel area. The daily total (direct and diffuse radiation) solar energy flux near the city of Las Vegas has an annual average of 500 cal /cm^2 per day. Assume that the solar plant will have to also store sufficient energy during the day to meet an equivalent demand at night.		