BITS, PILANI – DUBAI
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI
III Year II Semester: 2009 - 2010
Course: ME C314 Power Plant Engineering
Comprehensive Examination [Closed Book]

Max.Marks: 40 | **Mechanical** | **Date: 25-05-2010**
Weightage: 40 % | **Time: 3 hours**

Note: (i) Answer all Question in a sequence (ii) Assume suitable value if required and clearly state them (iii) Thermodynamics tables will be provided (iv) Answer Every Question on a fresh page
*(v) Answer in the **BLUE COLOUR** main answer book only*

Q.1 The following loads are connected to a power plant:

Type of load	Max.demand [MW]	Diversity factor	Demand Factor
Domestic	15	1.25	0.70
Commercial	25	1.20	0.90
Industrial	50	1.30	0.98

If the overall diversity factor is **1.5**, determine (a) the maximum load and (b) the connected load of each. **[3 Marks]**

Q.2. Steam at **20 bar**, **360^{0}C** is expanded in a steam turbine to **0.08** bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. **(a)** Assuming ideal processes, find per kg of steam the net work and the cycle efficiency. **(b)** If the turbine and the pump have each **80 %** efficiency, find the percentage reduction in the net work and cycle efficiency.

[5 Marks]

Q.3. A single jet impulse turbine of 10MW capacity is to work under a head of **500 m**. If the specific speed of the turbine is **10**, the overall efficiency is **80 %** and the coefficient of velocity is **0.98**, find the diameters of the jet and the bucket wheel. Assume the speed of the bucket wheel as **0.46** of the velocity of jet.

[4 Marks]

Q.4. Volumetric analysis of products of combustion of a hydrocarbon fuel is as under: **CO_2= 12.5 %, CO = 0.3 %, O_2 = 5 % N_2** is found by difference. Determine (a) air: fuel ratio (b) carbon and hydrogen percentage by mass (c) percentage of excess air. Take CxHy for fuel. **[5 Marks]**

Q.5. In an impulse turbine the mean diameter of the blade is **1.05 m** and the speed is **3000 rpm**. The nozzle angle is **18^{0}C**, the ratio of blade speed to steam speed is **0.42** and the ratio of the relative velocity at outlet from the blades to that at inlet is **0.84.** The outlet angle of the blade is to be made **3 ^{0}** less then the inlet angle. The steam flow is **10 kg /** s. Draw the velocity diagram for the blades and drive the following:

(i) Tangential thrust on the blades (ii) Axial thrust on the blades

(iii) Resultant thrust on the blades (iv) Power developed in the blades

(v) Blade efficiency **[5 Marks]**

Q.6. The following readings were obtained during a boiler trial which is shown in Fig 1.

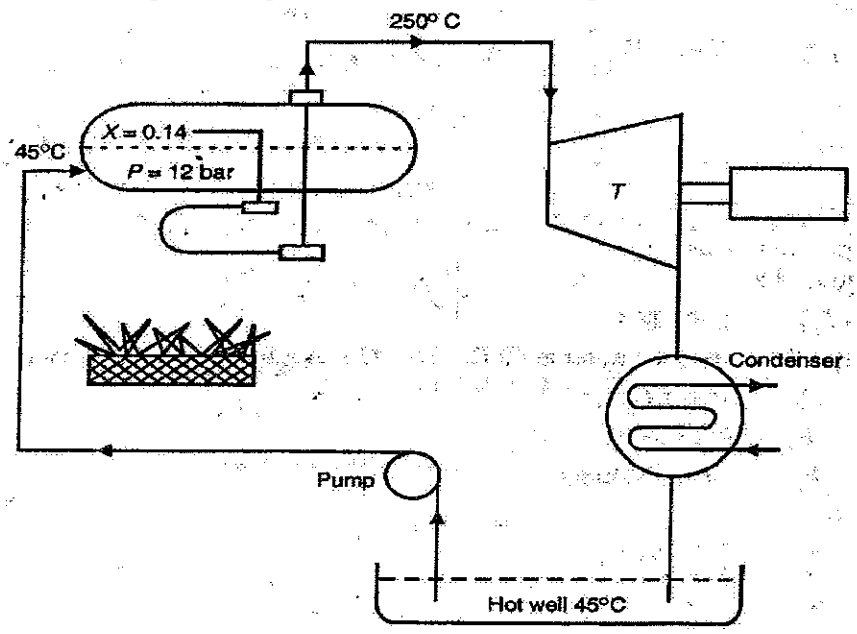

Fig.1

Boiler trial duration: **60 min**, Steam generated : **5250 kg**, Coal burnt : **695 kg**, Calorific value of coal burnt : **30200 kJ / kg,** Boiler pressure : **12 bar**, Dryness fraction : **0.94**, Temperature of steam leaving the superheater : **250^{0}C**, Temperature of hot well : **45^{0}C**.

- Calculate the following without superheater

(I) Equivalent of evaporation in kg / kg of coal (ii) Thermal efficiency of boiler

- Also Calculate the following with superheater

(I) Equivalent of evaporation in kg / kg of coal (ii) Thermal efficiency of boiler

(iii) Heat supplied by the superheater **[5 Marks]**

Q.7. During a trial of a single-cylinder, 4-stroke diesel engine the following observations were recorded:

(a) Bore = **340 mm**, (b) Stroke = **440 mm**, (c) RPM = **400,** (d) Indicated mean effective pressure = **4.65 bar** (e) Mechanical efficiency = **82 %**, (f) Mass of fuel used = **10.6 kg/h**, (g) Calorific value of fuel **49 500 kJ / kg,** (h) Mass of cooling water circulated = **25 kg /min**, (i) Rise in temperature of cooling water = **25^0C**, and (j) Temperature of exhaust gases = **400 ^{0}C**. Take: Specific heat of exhaust gases **(c_p) 1.05 kJ / kg-C,** Specific heat of water= **(c_p) 4.18 kJ / kg-C,** Ambient temperature = **25^0C**.

- The mass analysis of fuel is :
  (a) Carbon = **84 %** (b) Hydrogen = **15 %** (c) Incombustible = **1 %**
- The volume analysis of exhaust gases is:
  (a) Carbon dioxide = **9 %** (b) Oxygen = **10 %** (c) Nitrogen = **81 %**
  Draw up heat balance sheet on minute basis. **[5 Marks]**

Q.8. Derive an expression for the overall efficiency of heat loss in between in series of combined cycle power generation. **[2 Marks]**

Q.9. Explain the variation of bed pressure drop with superficial velocity in fluidized bed combustion with neat sketch. **[3 Marks]**

Q.10. With neat sketch explain about BWR system with internal and external circulation. **[3 Marks]**

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III Year II Semester 2009-2010 [Mechanical]

Test No.2 (Open Book)

Course No. ME C 314 **Course Title:** POWER PLANT ENGINEERING **Weightage:** 20%

Date: 02-05-2010 **Max.Marks:** 20 **Duration:** 50 min.

Notes: (i) *Answer all the questions* (ii) *Draw neat sketches wherever necessary*

- *(iii) Make suitable assumptions if required and clearly state them*

Q.1. Following readings were obtained during a trial on two boilers which is shown in Fig 1 and Fig.2.

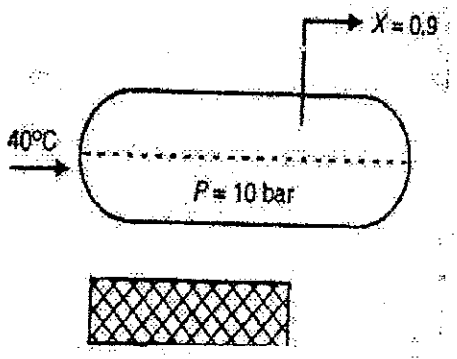

Fig.1

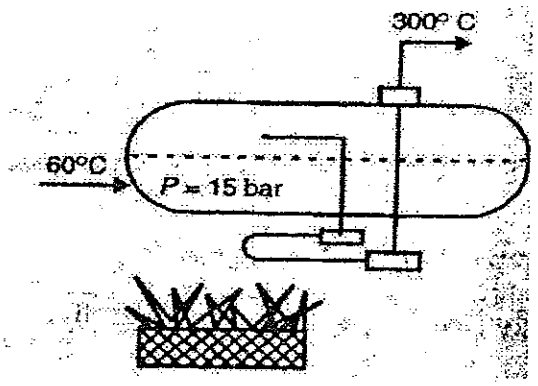

Fig.2

Boiler	Pressure	Quality and steam	Evaporation rate	Feed water temp
1	10 bar	0.9 dry	8.5 kg / kg of fuel	40 ^{0}C
2	15 bar	300 ^{0}C	8.0 kg / kg of fuel	60 ^{0}C

Fuel used has a calorific value of 30 000 kJ/kg. Compare these boilers in respect of equivalent evaporation and thermal efficiency. [8M]

Q.2. A single stage steam turbine is supplied with steam at 5 bar, 200 ^{0}C at the rate of 50 kg / min. It expands into a condenser at a pressure of 0.2 bar. The blade speed is 400 m/s. The nozzles are inclined at an angle of 20 ^{0} to the plane of the wheel and the outlet blade angle is 30 ^{0}. Neglecting friction losses, Determine the power developed, Blade efficiency and stage efficiency. [8M]

Q.3. Dry cooling towers have attracted much attention now a day. But it is not suitable for modern and bigger power plants. Give a justification for the above statement. [4M]

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BITS, Pilani –Dubai

Dubai International Academic City, Dubai, U.A.E

III Year II Semester 2009-2010 [Mechanical]

Test No.1 (Closed Book)

Course No. ME C 314 **Course Title:** POWER PLANT ENGINEERING **Weightage:** 25%

Date: 21-03-2010 **Max.Marks:** 25 **Duration:** 50 min.

Notes:

- *Answer all the questions*
- *Draw neat sketches wherever necessary*
- *Make suitable assumptions if required and clearly state them*

Q.1. A simple Rankine cycle works between pressures **28 bar** and **0.06 bar**, the initial condition of steam being dry saturated. Calculate the cycle efficiency. Relevant steam table extract is given below. [7M]

p(bar)	t (^{0}C)	Sp.Volume(m^3/kg)		Sp.enthalpy (kJ/kg)			Sp.entropy(kJ/kgK)		
		v_f	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
0.06	36.18	0.001006	23.741	151.5	2416.0	2567.5	0.521	7.810	8.331
28	230.0	0.001209	0.0713	990.5	1811.5	2802.0	2.611	3.600	6.210

Q.2. a) Briefly explain about the advantages of combined cycle power Generation. [3M]

b) Draw the flow diagram of **PFBC** combined power cycle and explain about its operation. [4M]

Q.3. A sample of coal burnt in a Lancashire boiler has the following consumption by weight: carbon **80 %**, hydrogen **5 %**, oxygen **2 %**, sulphar **1 %** and remainder ash. The coal burns with **60 %** of excess air over the minimum quantity of air required for the complete combustion of the fuel. Calculate the theoretical air required for complete combustion and the volumetric composition of the dry flue gas. If the flue gas leaving the plant is **315^{0}C** and that of the boiler house be **27 ^{0}C**, estimate the heat carried away by flue gases leaving the boiler plant. Assume c_p of gas to be **1.01 kg / kg-K.** [11M]

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BITS, PILANI-DUBAI

Dubai International Academic City, Dubai - IInd Sem 2009-10

Subject: Power plant Engineering **Course No: ME C314**
Duration: 20 Min **Max. Marks: 7**

Name of the student: ---------- **I.D.: ----------**

QUIZ II

1. Draw the T-S diagram for heat absorption in different heat exchanger of a water-tube boiler. **[1 M]**

2. What is fusible plug? Why is it used? **[1 M]**

3. What is circulation ratio? **[1/2 M]**

4. Write the relation to find out the pressure head developed for natural circulation. **[1/2 M]**

5. What is DNB? **[1/2 M]**

6. What is 'blow down'? Why is it needed? **[1 M]**

7. What do you mean by priming and foaming? **[1 M]**

8. What is a Fabric filter? **[1/2 M]**

9. What is ESP and write an overall Collection Efficiency. **[1/2 M]**

10. What do you mean by Deaeration? **[1/2 M]**

BITS, PILANI-DUBAI
Dubai International Academic City, Dubai
IInd Sem 2009-10

Subject: Power plant Engineering **Course No: ME C314**

DATE: 08 / 03 / 10

Duration: 15 Min **Max. Marks: 8**

Name of the student: ---------- **I.D.: ----------**

QUIZ I

1. The capital cost of power generation equipment in a steam power plant is Rs. 80 X 10^6. The useful life of the plant is 30 years and its salvage value is 5 % of the capital cost. Determine by the sinking-fund method the amount of money to be saved annually for replacement if the yearly rate of compound interest is 6 %. [3]

2. In a team power cycle, the steam supply is at 15 bar and dry saturated. The condenser pressure is 0.4 bar. Compare the Carnot and Rankine efficiencies of the cycle. Neglect pump work. Relavent steam table extract is given below. [2.5+2.5]

p(bar)	t (^{0}C)	Sp. Volume(m^3/kg)	Sp.enthalpy (kJ/kg)			Sp.entropy(kJ/kgK)
		v_g	h_f	h_{fg}	h_g	s_g
0.4	75.89	3.9934	317.7	2319.2	2636.9	7.671
15	198.3	0.13167	844.6	1945.3	2789.9	6.441

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