BITS PILANI, DUBAI CAMPUS
DUBAI INTERNATIONAL ACADEMIC CITY, DUBAI, UAE
SECOND SEMESTER 2010-2011
COMPREHENSIVE EXAMINATION (Closed book)

Year : ***111***	*Date* : ***29.5.2011***	
Course No. : ***ME C314***	*Course Title* : ***Power Plant Engineering***	
Duration : ***3 hours.***	*Max. Marks:* ***80***	*Weightage* : ***40%***

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 answer book only***

Q.1. The yearly duration curve of a certain plant can be considered as a straight line from **300MW** to **80 MW** as shown in Fig 1. Power is supplied with one generating unit of 200 MW capacity and two units of **100 MW** capacity each. Determine: (I) Installed capacity (II) Load factor (iii) Plant factor (iv) Maximum demand (v) Utilization factor **[9 Marks]**

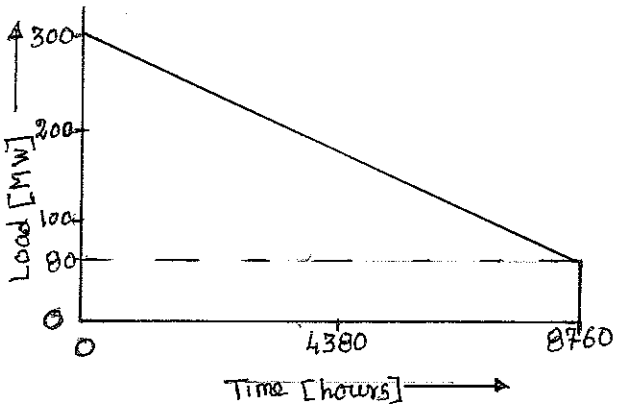

Fig.1

Q.2. The following data refer to a simple steam power plant:

S.No	Location	Pressure	Quality /temp	Velocity
1.	Inlet to turbine	6 MPa **(60 bar)**	**380°C**	-
2.	Exit from turbine inlet to condenser	10 kPa **(0.1bar)**	**0.9**	**200 m/s**
3.	Exit from condenser and inlet to pump	9 kPa **(0.09bar)**	Sat. Liquid	-
4.	Exit from pump and inlet to boiler	7 MPa **(70 bar)**	-	
5.	Exit from boiler	6.5 MPa **(65bar)**	**400°C**	-

Assume: Rate of steam flow=**10000 kg/h**, Specific heat of water is **4.18** kJ/kg-K

Calculate:

(i) Power output of the turbine
(ii) Heat transfer per hour in the boiler and condenser separately.
(iii) Mass of cooling water circulated per hour in the condenser. Choose the inlet temperature of cooling water **20°C** and **30°C** at exit from the condenser.
(iv) Diameter of the pipe connecting turbine with condenser. **[9 Marks]**

Q.3. What are the various types of combined cycle plants? Explain about Brayton-Rankine combined cycle power plant with neat sketch. **[8 Marks]**

Q.4. The analysis by mass of the coal fired in a boiler is **82 % carbon**, **8 % hydrogen**, **3 % Oxygen**, **7 % ash**. The boiler uses **0.19 kg/s** of air and is supplied **30 %** in excess of that required for theoretically correct combustion.

Calculate, (i) Calculate theoretically air required for combustion (ii) Volume of air taken in by the fan per sec, when the pressure and temperature of the air at the fan intake are **100 kN/m^2** and **18^0 C** respectively. **R** for air is **0.287 kJ / kg-K** (iii) Percentage composition by mass of the dry flue gases. **[8 Marks]**

Q.5. **[a]** What are the advantages and disadvantages of pulverized coal firing? **[3 Marks]**

[b] Explain the variation of bed pressure drop with superficial velocity in fluidized bed combustion with neat sketch. **[5 Marks]**

Q.6. Following readings were obtained during a trial on two boilers which is shown in Fig 2 and Fig.3.

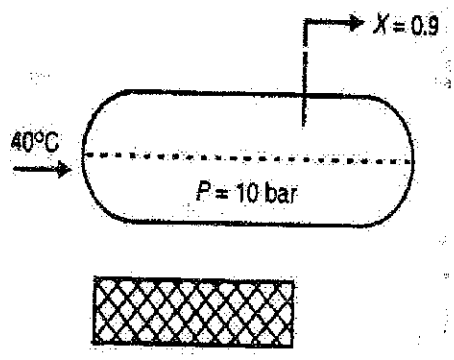

Fig.2

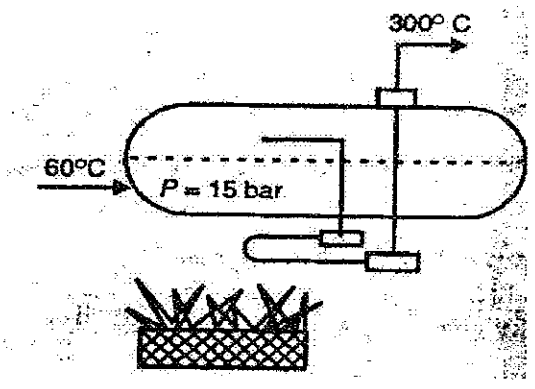

Fig.3

Boiler	Boiler Pressure	Quality and steam exit from boiler	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 and justify which one is more efficient. **[8 Marks]**

Q.7. In a steam impulse turbine the nozzle are inclined at **20^0** to the direction of motion of moving blades. The steam leaves the nozzle at **375 m/s**. The blade velocity is **165 m/s**. Calculate suitable inlet and outlet angle for blades in order that the axial thrust is zero. The relative velocity of steam as it flows over the blade is reduced by **15 %** by friction. Also determine the power developed for a flow rate of **10 kg/sec**. **[8 Marks]**

Q.8. A single jet impulse turbine of **10 MW** capacity is to work under a head of **500 m**. If the specific speed of the turbine is **10,** the overall efficiency is **80 per cent** and the coefficient of velocity is **0.98**, find the diameters of the jet and bucket wheel Assume the speed of the bucket as **0.46** of the velocity of jet. Assuming the velocity coefficient **C_v= 0.98** **[8 Marks]**

Q.9. During the trial of a single cylinder, single-acting oil engine, cylinder diameter **200 mm**, stroke **280 mm**, working on the two-stroke cycle the following observations were made:

Duration of trial	= 1 hour
Total fuel used	= 4.22 kg/hr
Calorific value	= 44670 kJ/kg
Proportion of hydrogen in fuel	= 15%
Total number of revolutions	= 21000/hr

Mean effective pressure	= 2.74 bar
Net brake load applied to a drum of 1 m diameter	= 600N
Total mass of cooling water circulated	= 495 kg/hr
Inlet Temperature of cooling water	= 13^0 C
Outlet Temperature of cooling water	= 38°C
Mass of air used	= 135 kg/hr
Temperature of air in test room	= 20°C
Temperature of exhaust gases	= 370°C
Enthalpy of steam in exhaust gases	=3157.7 kJ/min
Assume: Sp.heat (Exhaust. gases)	= 1.005 kJ/kg

Calculate the Indicated thermal efficiency, Brake power and draw up the heat balance in minute basis. **[10 Marks]**

Q.10. List out the various types of thermal reactors in Nuclear power plant? **[4 Marks]**

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BITS, Pilani –Dubai

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

III Year II Semester 2010-2011 [Mechanical]

Test No.2 (Open Book)

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

Date: 15-05-2011 **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*
(iv)***Steam tables and Graph sheet will be provided***

1. During a trial of a single-cylinder, 4-stroke diesel engine the following observations were recorded: **[7 M]**

Bore	= 340 mm
Stroke	= 440 mm
r.p.m.	= 400
Area of indicator diagram	= 465 mm^2
Length of diagram	= 60 mm
Spring constant	= 0.6 bar/mm
Load on hydraulic dynamometer	= 950 N
Dynamometer constant	= 7460
Fuel used	= 10.6 kg/h
Calorific value of fuel	= 49500 kJ/kg
Cooling water circulated	= 25 kg/min
Rise in temperature of cooling water	= 25°C
The mass analysis of fuel is:	
Carbon	= 84%
Hydrogen	= 15%
Incombustible	= 1%
The volume analysis of exhaust gases is:	
Carbondioxide	= 9%
Oxygen	= 10%
Nitrogen	= 81%
Temperature of exhaust gases	= 400°C
Specific heat of exhaust gases	= 1.05 kJ/kg°C

Ambient temperature = 25°C

Partial pressure of steam in exhaust gases = 0.030 bar

Specific heat of superheated steam = 2.1 kJ/kg°C

Draw up heat balance sheet on minute basis.

2. The following data refer to a boiler plant consisting of an economizer, a boiler and a superheater:
   Mass of water evaporated per hour = 5940 kg, mass of coal burnt per hour = 675 kg, C.V. of coal = 31600 kJ/kg, pressure of steam at boiler stop value = 14 bar, temperature of feed water entering the economizer = 32°C, temperature of feed water leaving the economizer = 115°C, Dryness fraction of steam leaving the boiler and entering superheater is 0.96, temperature of steam leaving the superheater = 260°C, specific heat of superheated steam = 2.3 kJ/kg-K, specific heat of water = 4.18 kJ/kg-K. Determine: (i) Percentage of heat in coal utilized in economizer, boiler and superheater. (ii) Overall efficiency of boiler plant. **[7 M]**

3. In a single stage impulse turbine the mean diameter of the blade ring is 1 metre and the rotational speed is 3000 r.p.m. The steam is issued from the nozzle at 300 m/s and nozzle angle is 20°. The blades are equiangular. If the friction loss in the blade channel is 19% of the kinetic energy corresponding to the relative velocity at the inlet to the blades, what is the power developed in the blading when the axial thrust on the blades is 98 N? **[6 M]**

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BITS, Pilani –Dubai

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

III Year II Semester 2010-2011 [Mechanical]

Test No.1 (Closed Book)

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

Date: 27-03-2011 **Max.Marks:** 25 **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. The input-output curve of a **50MW** power station is given by:

$$\mathbf{I = 4 \times 10^6 (8 + 8L + 0.4L^2)\ kJ / hour}$$

Where **I** is the input in kJ / hour and **L** is load in **MW**

(i) Determine the heat input per day to the power station if it works for 20 hours at full load and remaining period at no load.

(ii) Also find the saving per kWh of energy produced if the plant works at full load for all 24 hours generating the same amount of energy. [8 M]

Q.2. In a Rankine cycle, the steam at inlet to turbine is saturated steam **(x = 1)** at pressure of **35 bar** and the exhaust pressure is **0.2 bar**. The mass flow rate of steam is **9.5 kg/s**. Determine: a) The pump work b) The turbine work c) The Rankine efficiency d) Heat losses in the condenser d) The dryness at the end of expansion. Relevant steam table extract is given below. [8 M]

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
0.20	60.09	0.001017	7.6498	251.5	2358.4	2609.9	0.8321	7.0773	7.909
35	242.5	0.001235	0.0570	1049.7	1752.3	2802.0	2.725	3.398	6.123

Q.3. The percentage composition by mass of a solid fuel in a boiler is given below:

C = 90 %, H_2 =3.5 %, O_2 = 3 %, N_2 = 1 %, S =1 % and the remainder being ash.

(a) Find the mass of air required per kg of fuel for complete combustion and mass analysis of the dry products of combustion.

(b) If **50 %** excess air is supplied in actual combustion, determine the volumetric analysis of the products and also the mass of flue gas per kg of fuel. [9 M]

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BITS, Pilani –Dubai

PART-A

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

III Year II Semester 2010-2011 [Mechanical]

Quiz.2 (Closed Book)

Course No. ME C314 **Course Title:** power plant engineering **Weightage:** 7 %
Date: 20-04-2011 **Max.Marks:** 7 **Duration:** 20 min.

STUDENT NAME: ----------**I.D No:** ----------

Q.No	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Answer														

[14 X 0.5 = 7 Marks]

Q.1. In Chain Grate stoker, the grate surface is made up of a series of _____joined together by bars or pins to form an endless chain.

(a) Aluminium casting

(b) Iron casting

(c) Combination of Bricks and Cast iron

(d) Mild steel

Q.2 When air is steadily increased through a fixed bed, a point is eventually reached at which the pressure drop across the bed becomes equal to the weight of the particles per unit cross-sectional area of the bed. This critical velocity is called _____

(a) Maximum fluidization velocity

(b) Superficial velocity

(c) Medium fluidization velocity

(d) Minimum fluidization velocity

Q.3 In fluidized bed combustion solid fuel, the temperature of the bed is controlled between

(a) 600 – 700 ^{0}C (b) 700 – 800 ^{0}C (c) 800 – 1100 ^{0}C (d) 1100 – 1250 ^{0}C

Q.4. Which of the following is not related to crushing of coal ?

[a] Ball mill [b] Ring type [c] Hammer mill [d] Bradford breaker

Q.5. _____is a separating chamber wherein high-speed gas rotation is generated for the purpose of 'centrifuging' the particles from the carrying gases.

a) Magnet separator

(b) Electrostatic precipitators

(c) Gravitational separator

(d) Cyclone separator

Q.6. What is circulation ratio?

a) It is the ratio of the mass flow rate of steam generation to the rate of circulating water.

(b) It is the ratio of the mass flow rate of circulating water to the rate of steam generation.

(c) It is the ratio of the mass flow rate of circulating water to the rate of super heated steam generation

(d) It is the ratio of the mass flow rate of circulating hot water to the rate of circulating cold water.

Q.7 Which of the following is not related to fire tube boiler?

[a] Locomotive boiler [b] Lancashire boiler [c] Scotch-marine boiler
[d] La Mont boiler

Q.8. Overall collection efficiency for ESP is defined by

[a] Mass of all particles retained by collector / mass of all particles entering collector
[b] mass of all particles entering collector / Mass of all particles retained by collector
[c] Mass of all particles driven out by collector / mass of all particles entering collector
[d] mass of all particles entering collector / Mass of all particles driven out by collector

Q.9. What is circulation ratio?

a) It is the ratio of the mass flow rate of steam generation to the rate of circulating water.

(b) It is the ratio of the mass flow rate of circulating water to the rate of steam generation.

(c) It is the ratio of the mass flow rate of circulating water to the rate of super heated steam generation

(d) It is the ratio of the mass flow rate of circulating hot water to the rate of circulating cold water.

Q.10. Air to cloth ratio is _____

[a] volumetric flow rate of gas / surface area of fabric filter
[b] surface area of fabric filter / volumetric flow rate of gas
[c] Volume of fabric filter / volumetric flow rate of gas
[d] Height of fabric filter / volumetric flow rate of gas

Q.11. The ratio of heat actually used in raising steam to the heat liberated in the boiler furnace by the combustion of fuel is called

[a] equivalent evaporation
[b] Generation factor
[c] Factor of evaporation
[d] Boiler efficiency

Q.12. Which of the following form part(s) of boiler mountings? Select the correct answer using the codes given below:

[a] 2 alone
[b] 1 and 3
[c] 2,3 and 4
[d] 1,2,3 and 4

Q.13. An economizer unit of a boiler is located between

[a] forced draught fan and furnace
[b] furnace and superheater
[c] superheater and air preheater
[d] Air preheater and chimney

Q.14. Once-through boiler is named as such because

[a] flue gas passes only in one direction
[b] steam is sent out only one direction
[c] air is sent through the same direction
[d] there is no recirculation of water

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BITS, PILANI-DUBAI
Dubai International Academic City, Dubai
IInd Sem 2010-11

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

DATE: 02 / 03 / 11

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

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

QUIZ I

1. A 300 MW thermal power plant station is to supply power to a system having maximum and minimum demand of 240 MW and 180MW respectively in a year. Assuming the load duration curve to be a straight line as shown in the figure 1, estimate the (a) load factor (b) Capacity factor.

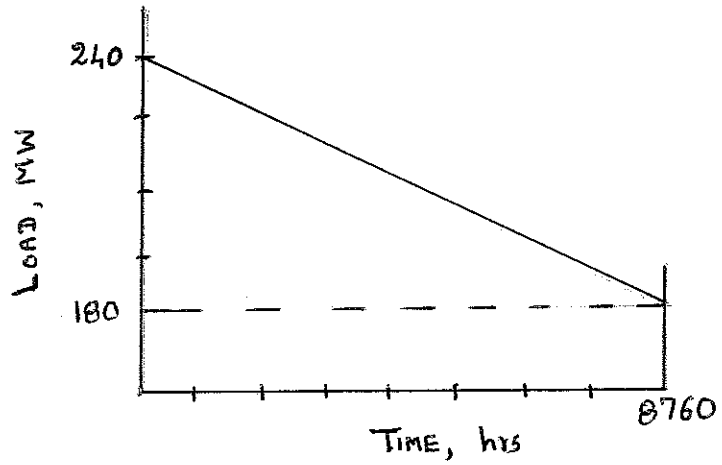

Fig.1

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. Relevant steam table extract is given below.

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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