BITS, PILANI – DUBAI

Second Semester III Year Mech 2008 – 2009

Comprehensive Exam (Closed book)

(Steam tables and Mollier charts are allowed)

Course No & Title : ME C314 Power Plant Engineering

Date: 02/06/2009 Time 10.00 AM to 1.00 PM Max: 80 marks

Answer All Questions

1) Explain with neat diagrams the working of a combined MHD – Steam power Plant. (5 MARKS)

2) Briefly explain the construction and working of a three zone horizontal closed type feed water heater. Also draw a graph showing the temperature profiles along the path length in a three zone feed water heater. (5 MARKS)

3) Draw and explain the working of a Circulating Fluidized Bed combustion system. (5 MARKS)

4) Very large hydro electrical power plants are not favored due to its ecological damage. Hence many mini and micro hydro electrical power stations are planned to trap the hydro potential. It is proposed to supply the following power demand through a mini hydroelectric – thermal power plant combination. The hydro electric power plant will supply the base load and the thermal plant will supply the peak demand. (a) Identify the generating and standby units and their operating schedule for the combined hydro electric-thermal power plant. (b) Calculate the load curve, load duration curve, load factor and capacity factor.(10 MARKS)

Time	6.00 am-8.00 am	8.00 am – 12 noon	12 noon-1.00 pm	1.00 pm – 5.00 pm	5.00 pm – 7.00 pm	7.00 pm – 9.00 pm	9.00 pm -11 pm	11.00 pm – 6 am
Load MW	3.5	8	3	7.5	8.5	10	4.5	2

5) The total power out put of a combined gas turbine-steam power plant is 200 MW. The calorific value of the fuel burned is 43.3 MJ/kg. The exhaust gas from the gas turbine is reheated to a temperature of 750 C with additional fuel burned in the gas. The pressure ratio for the gas turbine is 7.5 and air inlet temperature is 15 C and the maximum cycle temperature is 750 C. The flue gas leaves the steam generator at a temperature of 100 C. The steam supplied to the steam turbine at 50 bar and at a temperature of 600 C and the condenser pressure of the exhaust steam is 0.1 bar. Find the (a) fuel consumption rate, (b) Steam flow rate (c) air flow rate and air fuel ratio, Take Cp= 1.11 kJ/kgK, γ= 1.33 for combustion gases, and Cp=1.005 kJ/kgK and γ =1.4 for air. Neglect the pump work. (10 MARKS)

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6) A 100 MW power plant runs on fuel oil of calorific value 42 MJ/kg with a over all efficiency of 40 %. The fuel analysis on mass basis yields: carbon 84%, Hydrogen 10% sulphur 3.2 %, oxygen 1.6% and reminder incombustible. The analysis of flue gas by volume is: Combined $CO_2 + SO_2 = 15.72\%$; $O_2 = 1\%$. CO and SO_3 are Nil. Calculate the (a) mass of fuel supplied (b) mass of air supplied & % of excess air (c)Mass of dry flue gas formed and the mass of SO_2 formed.
Also for this plant, if the atmospheric air at 30C is supplied by an ID fan with a draught of 250 mm WC and exhaust temperature of 200C with a fan efficiency of 70 %, find the motor capacity of the ID fan. (10 MARKS)

7) Find the number and length of a super heater coils of 50 mm id and 5 mm thickness to be provided if the steam exit is at 60 bar, 500C and flows with a velocity of 10 m/s and mass flow of 80 kg/s. Due to restriction of materials, the heat flux in the super heater coils is to be limited to 140 kW/m^2. If the pitch of the coil is 80 mm and the clearance on the two sides of the duct of width 4.8 m is 5 mm, find the vertical height of the super heater coils.(10 MARKS)

8) A Pelton wheel has to be designed for the following specifications: Power developed = 6 MW, net head available = 300 m, Speed of the wheel = 550 rpm. Ratio of jet diameter to wheel diameter = 0.1, hydraulic efficiency = 85%. Assume a velocity coefficient of 0.98 and speed ratio of 0.45, find (a) the number of jets required, (b) diameter of each jet (c) diameter of wheel and the (d) quantity of water required. (5 MARKS)

9) A 1000 MW nuclear power plant is being planned for the rapidly expanding city of Dubai. The total system should have a capacity factor of 90%. The thermal to electrical energy conversion efficiency using a water-steam Rankine cycle with sub-critical pressure is 35%. The nuclear to thermal energy conversion efficiency in the reactor is 95%, due to the emissions of neutrinos which are not captured in the core. For simplicity assume U235 is the only fissionable material. By weight, U-235 constitutes 0.71% of natural uranium, and the rest is U-238. The reactor fresh fuel requires a higher fraction of U-235 (typically 4.4% in today's light water cooled reactors) which is obtained by isotopic enrichment of the natural uranium. However, due to the energy intensity of the operation of the enrichment plants when the U-235 fraction gets to be small, the discarded uranium in the enrichment process (called uranium tails) has 0.25% U-235 fraction. The fission of one gram of U-235 produces 1 MW-day worth of nuclear energy. If an advanced nuclear power reactor is to be used, what amount of natural uranium will be needed to fuel the plant annually?
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 that the calorific value of the fuel burned is 40.0 MJ/kg. Compare and contrast the two types of power plants based on your calculated fuel requirements and the associated problems on natural resource depletion and emissions.
(10 MARKS)

10) For a diesel generator, the following data were observed for an one hour trial of an engine having dimensions: 0.3 m bore X 0.45 m stroke, fuel consumption = 11.4 kg, Calorific value of the fuel used = 42 MJ/kg, imep = 6 bar net load on brake drum dynamometer = 1500 N, brake drum diameter = 1.8 m, brake rope diameter = 20 mm, quantity of cooling water supplied = 600 kg, temperature rise of cooling water = 55 C, quantity of air supplied = 250 kg, exhaust gas temperature = 420 C. Specific heat of exhaust gases = 1.04 kJ/kgK and ambient temperature = 20C. Estimate (a) the indicated power, (b) the brake power (c) the indicated thermal efficiency and (d) draw up an energy balance sheet of the engine. (10 MARKS)

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Best of Luck!!!

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BITS, PILANI – DUBAI

First Semester III Year Mech 2008 – 2009

Test II Open Book

Course No & Title : ME C314 Power Plant Engineering

Date : 12/04/2009 | Time 50 minutes | Max: 40 marks

Answer All Questions

(Text books and reference books on power plant engineering, hand written class notes allowed)

1) Assume that you are the plant design engineer of a new 500 MWe power plant that is being planned for the rapidly expanding city of Dubai. The steam boiler supplier, Siemens Power Solution, specifies the super heated steam and feed water supply conditions as follows:
Steam flow rate: 25 tones/hour; Steam outlet Pressure: 50 bar; Steam Boiler efficiency: 78% if you use a coal having the calorific value of 23 MJ/kg. For achieving this efficiency level, the air requirement is 20 kg per kg of fuel burned with a chimney draft of 50 mm of water column and with a plenum chamber pressure of 200 mm water column. The flue gas temperature at boiler exit will be 350 C and when it reaches the chimney, it looses around 30 C of its temperature. The average atmospheric temperature in Dubai is 36 C.

With suitable assumptions on stack exit velocity and fan efficiency, calculate the following design parameters:
(a) Stack height (b) stack Diameter at its base (c) rate of air supplied (d) FD fan capacity and (e) ID fan capacity.

(20MARKS)

2) A Fluidized bed is packed with coal and limestone in the ratio of 3:1. Their densities are 2000 kg/m^3 and 4500 kg/m^3 respectively. The density of the fluidized bed during its operation is 1750 kg/m^3. The bed particles are ground to a mean size of 500 μm. Assume that the fluidized bed operates with an air density of 1.3 kg/m^3. Calculate the Voidage of the bed and the minimum fluidization velocity. Take viscosity of air as 1.9×10^{-5} $kg/m-s$.

(10MARKS)

3) The steam generator of a power plant has a 15 m long down comer-riser which operates at a pressure of 200 bar and at a velocity of flow of 0.7 m/s. Heat is added to it uniformly with a maximum heat flux of 140 kW/m^2. The slip ratio is 1.7. Calculate the pressure head developed by the natural circulation. Assume that the exit steam quality is 60 %.

(10MARKS)

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Best of Luck!!!

BITS, PILANI – DUBAI

Second Semester III Year Mech 2008 – 2009

Test I

Course No & Title : ME C314 Power Plant Engineering

Date : 01/03/2009

Time 50 minutes
Answer All Questions
(Steam Tables, Mollier Charts allowed)

Max: 50 marks

1. Why more than two reheats are not used in practice? (2 MARKS)
2. What is forced outage rate? (2 MARKS)
3. What is repowring of a power plant? (2 MARKS)
4. Write short notes on the working principles of (a) Thermionic-steam power plant and (b) Thermoelectric- Steam power plant. (4 MARKS)

5. A power station has a maximum demand of 100 MW and the daily load on the station is:

6 am to 8 am	35 MW	5 pm to 7 pm	85 MW
8 am to 12 noon	80 MW	7 pm to 9 pm	100 MW
12 noon to 1 pm	30 MW	9 pm to 11 pm	45 MW
1 pm to 5 pm	75 MW	11 pm to 6 am	20 MW

(a) Draw the load curve and the load duration curve.
(b) Choose the size and number of generating units
(c) List the operating schedule of the units
(d) What will be the capacity of reserve plant? Justify your decision.
(e) Calculate the load factor, Plant capacity factor and plant use factor. (20 marks)

6. Consider a combined Gas turbine- Steam turbine power plant. The pressure ratio of gas turbine is 8, the air inlet temperature is 25 C and the maximum cycle temperature is 750 C. Supplementary heating is done to rise the gas temperature to 750 C and the gas leaves the steam generator at 100C. The steam supplied to the steam turbine at 50 bar and 500 C and the condenser pressure is 0.1 bar. The total power output of the plant is 200 MW. The calorific value of the fuel burned is 42 MJ/kg. Neglecting the effect of mass flow rate of fuel, determine the
   (a) flow rates of air and steam required
   (b) Power output of steam and gas turbines
   (c) Thermal efficiency of the combined plant
   (d) Air-fuel ratio.

Take Cp = 1.11 KJ/kg K, γ = 1.3 for combustion gases and Cp = 1.005 KJ/kg K, γ = 1.4 for air, Neglect the pump work.

(20 MARKS)

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Best of Luck!!!

BITS, PILANI – DUBAI

Second Semester III Year Mech 2007 – 2008

Quiz III

Course No & Title : ME UC 314 Power Plant Engineering

Answer All Questions (10X 1=10 marks)

1) The natural uranium consists of _____% U^{238}, _____% U^{235} and _____% U^{234}.

2) 1 g of mass is equivalent of _____ J of energy and one neutron is equivalent of _____J of energy.

3) Fission can be caused by a particles, protons deuterons, X-rays and Neutrons. But _____ is most suitable because_____

4) Write down the fission chain of U^{235}.

5) What is HTGCR and LMFBR?

6) What is cladding?

7) Some of the cladding materials are _____ and _____

8) In a graphite moderated helium cooled HTGR _____ is used as the fission material and _____is used as fertile material.

9) Write down two typical fusion reactions of deuterium

10) The self sustaining fusion reaction occurring between deuterium and tritium at a temperature of _____ releases _____MeV of energy.

Name :_____ **ID No :**_____

BITS, PILANI – DUBAI

Second Semester III Year Mech 2008 – 2009

Quiz II

Course No & Title : ME C 314 Power Plant Engineering

Answer All Questions (10 marks)

1. Define Sphericity of a particle. (2)

2. What is slugging? (1)

3. The hot solids at the bottom of the CFB act as _____ (1)

4. Write down the different types of coal gasifiers: (2)

5. The basic reactions of the gasification are: (2)

6. IGCC stand for _____ (1)

7. The drag coefficient depends on _____ (1)

Best of Luck!!!!

BITS, PILANI – DUBAI

Second Semester III Year Mech 2008 – 2009

Quiz I

Course No & Title : ME C 314 Power Plant Engineering

Answer All Questions (10X 1=10 marks)

1. The doubling time for the increase in power sector with a growth rate of i= 7 % is _____

2. The Plant use factor is defined as _____

3. In a counter flow heat exchanger the minimum temperature between the fluids is known as _____.

4. When the mean temperature of heat addition for a Rankine cycle decreases, the cycle efficiency:

   a) Increases b) Decreases c) Does not change

5. The ideal Stirling cycle has the same efficiency of _____ cycle

6. The regenerative cycle efficiency is maximum when the total enthalpy rise during the water heated from condenser outlet temperature to boiler saturation temperature will be

   a. Equal to the enthalpy rise in super heating
   b. Equal to the enthalpy rise in reheating
   c. Divide equally between feed water heater and HRSG
   d. Divide equally between feed water heater and economizer

7. If the boiler loss is 8%, mechanical loss is 5%, generator loss is 7% , loss in auxiliary is 5% and overall efficiency of the power plant is 35%, then the cycle efficiency is _____

8. In a combined power plant mercury is used in the topping cycle due to the fact that mercury has:

   a) Low saturation temperature
   b) Low Vaporization pressure
   c) High Vaporization pressure
   d) Lower critical pressure and temperature than water

9. If we use helium instead of air as the working medium in a Brayton cycle the cycle efficiency will increase. This is due to_____

10. When steam is adiabatically throttled,

    a. Energy increases b) energy decreases
    c. Exergy increases d) exergy decreases

Best of Luck!!!!