BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR, HOW-3
B.E. (Mech) Part-II 4th Semester Final Examination, 2013.

Subject : Applied Thermodynamics (ME-402)

Branch : Mechanical Engineering

Time: 3 Hours. Full Marks: 70

Answer six questions taking three from each half.

All questions are of equal value.

FIRST HALF

1. (a) State the locations and functions of the following components in a boiler plant.
(i) Economizer, (ii) Blow off cock, (iii) Steam stop valve, (iv) Fusible plug and (v) Water level indicator

(b) The following observations were made in a boiler trial:
Coal consumed = 200 kg
Steam pressure = 11.5 bar
Feed water temperature = 34^0C
Water evaporated = 2000 Kg
The dryness fraction of steam = 0.95
C.V. of coal = 29.8 MJ/kg
Calculate the equivalent evaporation from and at 100^0C per kg of coal and efficiency of the boiler. What will happen to the rest of the heat released due to the combustion of coal?

2. (a) What are the advantages of multistage compressors over single stage compressors? Derive the condition of minimum work with complete intercooling in a two stage compressor.

(b) A single-stage single-acting compressor running at 1000 rev/min delivers air at 25 bar. For this purpose the induction and free air conditions can be taken as 1.013 bar and 15^0C, and FAD as 0.25 m^3/min. The clearance volume is 3% of the swept volume and the stroke to bore ratio is 1.2:1. Calculate (i) the bore and stroke, (ii) the volumetric efficiency, (iii) the indicated power and (iv) the isothermal efficiency. Take the index of compression and re-expansion as 1.3.

3. (a) State why P-h diagram is more suitable for calculations over T-s diagram in case of a vapour compression refrigeration system. Identify the four main components of a mechanical vapour compression system. State their functions also. Define one ton of refrigeration.

(b) A vapour compression refrigeration system uses methyl chloride (R-40) as refrigerant and operates between temperature limits of -10^0C and 45^0C. At entry to the compressor, the refrigerant is dry saturated and after compression it acquires a temperature of 60^0C. Find the COP of the refrigeration system. The relevant properties of methyl chloride are as follows:

Temperature (^{0}C)	h_f (kJ/kg)	h_g(kJ/kg)	s_f (kJ/kg-K)	s_g (kJ/kg-K)
-10	45.4	460.7	0.183	1.637
45	113.0	483.6	0.485	1.587

You can use only the data given in the question papers for this problem.

4. (a) When the Brayton cycle is reversed and operated as refrigerator, show that the ideal COP of such cycle is given as $COP = \dfrac{1}{\left(\dfrac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}} - 1}$ where p_2 and p_1 are the high and low pressure limits of the cycle respectively.

(b) A Bell –Coleman cycle works between 1 bar and 6 bar. Compression follows the law $pv^{1.25} = C$ and expansion follows the law $pv^{1.3} = C$. Find the COP and capacity of the plant in Tons of Refrigeration, if the air flow is 0.5 kg/s. Assume compression and expansion begin at 7^0C and 37^0C respectively.

5. Write short notes (any three):
Lamont Boiler, Volumetric Efficiency of Compressor, Refrigerants, Centrifugal Compressor.

SECOND HALF

6 (a) Draw the T-s diagram of a Carnot vapor power cycle. Discuss each process in brief. Deduce the thermal efficiency of the cycle. Mention the major difficulties for using Carnot cycle in a steam power plant in practice.

(b) In a steam power plant operating under an ideal Rankine cycle, steam enters the turbine at 100 bar and 500^0C. After isentropic expansion, it leaves the turbine at 0.05 bar. Calculate (i) work ratio, (ii) specific steam consumption (SSC), (iii) heat rate and (iv) efficiency of the cycle. Use steam table.

7 (a) Draw p-v and T-s diagrams of a Diesel cycle. Mention each process and deduce the expression of its thermal efficiency.

(b) In a Diesel cycle, at the inlet of compression process the pressure and temperature of working fluid are 1 bar and 18^0c respectively. The compression ratio is 12. If the maximum cycle temperature is 2250^0c, estimate cut-off ratio and expansion ratio, specific heat addition and rejection, and thermal efficiency of the cycle. Assume that C_p and C_v for the working fluid are 1.005 and 0.718 kJ/Kg.K respectively.

8 (a) Discuss in brief the various methodologies that can be used for the enhancement of mean temperature of heat addition of the relevant cycle used in a steam power plant.

(b) With the help of a neat labeled diagram, discuss in brief the functioning of different components present in a nuclear reactor.

9 (a) Draw the relevant flow, p-v and T-s diagrams of a closed Brayton cycle. Discuss in brief the each process of the cycle and also deduce the expression of its thermal efficiency .

(b) In a gas turbine power plant operating under air standard Brayton cycle, the pressure and temperature of the working fluid at the inlet of the compressor are 1 bar and 15^0c respectively. The working fluid leaves the compressor at 8 bar. If the maximum cycle temperature is 1250^0c, find out (i) specific compressor work, (ii) specific turbine work, (iii) specific heat addition and heat rejection, and (iv) cycle efficiency. Assume that C_p and R for the working fluid are 1.005 and 0.287 kJ/Kg.K respectively.

!0 Write short notes on <u>any three</u> of the following:-

(a) Mean Effective pressure
(b) Stirling cycle
(c) Mean temperature of heat addition
(d) Binding energy