

**CS/B.Tech/EE/EVEN/SEM-4/ME(EE)-411/2014**

**2014**

**Thermal Engineering**

**Time Allotted : 3 Hours**

**Full Marks : 70**

**The figure in the margin indicate full marks.**

**Candidates are required to give their answers in their own words as far as practicable**

**GROUP – A**

**(Multiple Choice Type Questions)**

**1. Choose the correct alternative of the following ?     $10 \times 1 = 10$**

- i. A cycle consisting of two constant volume and two isothermal processes is known as –  
a) Carnot Cycle                  b) Joule Cycle  
c) Otto Cycle                  d) Stirling Cycle
- ii. Which is not a part of petrol engine :  
a) Valve mechanism                  b) Fuel injector  
c) Induction coil                  d) Air filter
- iii. Lancashire boiler has how many number of fire tubes in it –  
a) one                  b) two                  c) three                  d) four
- iv. In case of impulse turbine the pressure of the steam as it passes on the moving blades from entry to the exit –  
a) increases                  b) decreases                  c) remain same  
d) may increase or decrease depending upon the quality of entry steam

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- v. When the enthalpy or total heat of steam is  $h$  kJ/kg and the enthalpy or sensible heat of feed water is  $h_f$  kJ/kg, then the factor of evaporation is given by –
- a)  $\frac{h-h_f}{2257}$    b)  $\frac{h+h_f}{2257}$    c)  $\frac{h \times h_f}{2257}$    d)  $\frac{h \pm h_f}{2257}$
- vi. The basic limitation of natural circulation boilers is that they–
- a) operate at sub-critical pressure only  
b) operate at supercritical pressure only  
c) are large requiring large footprint & head space  
d) are unreliable in load following characteristic
- vii. When the steam entering a nozzle is dry and saturated, the value of critical pressure ratio is –
- a) 0.528   b) 0.487   c) 0.577   d) none of these
- viii. The ratio of work done per cycle to the swept volume in case of IC engine is called
- a) Compression index   b) Compression ratio  
c) Compression efficiency   d) Mean effective pressure
- ix. In a cyclone separator clean gas comes out from –
- a) top   b) bottom   c) sides   d) does not come out at all
- x. A heat engine is supplied heat at the rate of 30000 J/s and gives an output of 9 KW. The thermal efficiency of engine will be –
- a) 30%   b) 33%   c) 40%   d) None of the above

**Group-B**

(Short answer type questions)

**Answer any Three of the following   3X5=15**

2. In an impulse turbine the fixed nozzle angle is  $\alpha$ , the blades are equiangular, the blade velocity coefficient is K, show that

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maximum efficiency is -  $\frac{(1+k)\cos^2\alpha}{2}$

3. Write down the expression of Thermal Efficiency of an Otto cycle engine. If this engine has a Compression ratio is 6 : 1 calculate the Thermal efficiency of the given engine. Explain why the efficiency is so high compared to the realistic value by listing the flaws in the assumption made for the air standard Otto cycle.
4. Write the merits and demerits of fire tube and water tube boilers.
5. A sample of coal contains 78% carbon, 6% hydrogen, 1.2% nitrogen, 7.8% oxygen and 4% ash. Find minimum quantity of air required for complete combustion of 1 kg of coal.
6. Draw the valve timing diagram of a 4-stroke petrol engine and describe the major events.

**Group – C****(Long answer type questions)****Answer any Three of the following 3X15=45**

7. a) State the function of a chimney.  
b) Obtain the expression for natural draught in terms of M.M. of water gauge of a chimney.  
c) A chimney is 30 meter height and is filled with hot gases at a temperature of 288°C. The temperature of the outside air is 21°C. If the draught is 80% of theoretical draught, determine the available draught. The boiler use 18 kg of air per kg of fuel burnt.
8. a) Derive the expression of the thermal efficiency for constant pressure Ignition cycle. Define cutoff ratio, compression ratio and expansion ratio and also find the relation among them.  
b) A six cylinder petrol engine has a volume compression ratio of 5 : 1. Clearance volume in each cylinder is 110 cc. Engine consumes 10 kg of fuel per hour, whose  $C_v$  is 10000 Kcal/kg. Engine runs at 2400 rpm and the efficiency

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ratio is 0.66. Estimate the mean effective pressure developed.

9. (a) What are the basic elements of an electrostatic precipitator? State in brief it's working principle.

b) A gas turbine unit has pressure ratio of 6 : 1 and maximum cycle temperature of  $610^{\circ}\text{C}$ . The isentropic efficiencies of the compressors and turbine are 0.8 and 0.82 respectively. Calculate the power output in KW of an electric generator geared to the turbine when air enters the compressor at  $15^{\circ}\text{C}$  at the rate of 16kg/s. Take  $C_p = 1.005\text{KJ/kgK}$ ,  $\gamma = 1.4$  for the compression process. Take  $C_p = 1.11 \text{ KJ/kgK}$ ,  $\gamma = 1.33$  for the expansion process.

10. a) Steam is generated in a boiler at 30 bar.  $300^{\circ}\text{C}$  at the rate of 11kg/s with feed water entering economiser at  $27^{\circ}\text{C}$  & leaving at  $100^{\circ}\text{C}$ . During one hour test, 500kg fuel is used in boiler. CV on fuel is 35000kj/kg.

Find, I) the equivalent evaporation per kg of fuel. II) Efficiency of boiler.

b) Derive an expression in terms of critical pressure ratio for the condition of maximum discharge through nozzle.

c) Dry saturated steam is expanded in a steam nozzle from 12 bar to 0.3 bar. Using steam table calculate (i) dryness fraction of steam at exit (ii) heat drop (iii) velocity of steam at exit from nozzle when initial velocity is 140 m/s.

(5+5+5)

11. a) What is the difference between Impulse and Reaction turbine?

b) The speed of a single stage impulse turbine is 3000 rev/min and the mean blade diameter is 10m, the nozzle of the turbine is inclined at  $20^{\circ}$  to the plane of the wheel and moving blade inlet and outlet angles are  $35^{\circ}$  and  $30^{\circ}$ . Assuming a friction factor of 0.8 determine (i) the power developed for a stream consumption rate of 9000kg/hr. (ii) the blade or diagram efficiency, (iii).the axial thrust.

c) Draw the velocity and pressure diagram for a velocity compounded turbine. X-X-X \_\_\_\_\_ (4+8+3)