Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.TECH/EE(OLD)/SEM-4/ME(EE)-411/2013

2013

THERMAL POWER ENGINEERING

Time Allotted : 3 Hours   *Full Marks* : 70

The figures 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 alternatives for the following :   10 × 1 = 10

    i)   The tube diameter in case of controlled circulation steam generators as compared to natural circulations are

        a)   larger

        b)   smaller

        c)   same

        d)   independent of circulation.

    ii) The main function of drum in steam generator with drum is

        a)   to store water

        b)   to store steam

        c)   to separate steam from water

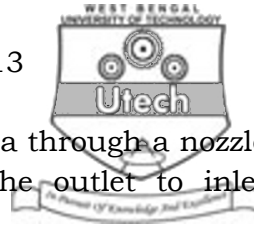   d)   to remove salt from water.

iii) The location of fan for induced draught is

    a) near bottom of chimney

    b) near bottom of furnace

    c) at the top of furnace

    d) anywhere permissible.

iv) A steam nozzle converts

    a) heat energy of steam into potential energy

    b) kinetic energy into heat energy

    c) heat energy of steam into kinetic energy

    d) potential energy into heat energy of steam.

v) Reheat factor for steam turbines

    a) decreases with increase in number of stages

    b) increases with increase in number of stages

    c) remains same irrespective of number of stages

    d) none of these.

vi) Bomb calorimeter is used to determine the calorific value of

    a) solid fuels only

    b) liquid fuels only

    c) gaseous fuels only

    d) solid as well as liquid fuels.

vii) The thermal efficiency of a good steam generator may be in the range of

    a) 80% to 90%   b) 50% to 60%

    c) 30% to 40%   d) 10% to 20%.

viii) Compression ratio of a petrol engine is in the range of

    a)   2 to 3   b)   7 to 12

    c)   16 to 20   d)   25 to 35.

ix) The specific fuel consumption of diesel engine as compared to petrol engine is

    a)   lower   b)   higher

    c)   same   d)   undetermined.

x) Basic closed cycle for gas turbine is

    a)   Carnot cycle   b)   Rankine cycle

    c)   Brayton cycle   d)   Stirling cycle.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following.   3 × 5 = 15

2. What is ignition lag ? Discuss the effect of engine variables on ignition lag.   2 + 3

3. Write short note on any *one* of the following :

    a)   Cyclone separator

    b)   Dust collector

    c)   E.S.P.

    d)   F.D. and I.D. fan.

4. Discuss about the valve timing diagram for four-stroke petrol engine with a suitable diagram.

5. Why are downcomers fewer in number and bigger in diameter than the riser tubes in a natural circulation boiler ?

6. Prove that maximum flow rate per unit area through a nozzle occurs when the ratio of pressure at the outlet to inlet pressure is equal to $\left(\dfrac{2}{n+1}\right)^{\frac{n}{n-1}}$, where n = isentropic index of expansion.

7. Derive an expression for maximum discharge rate of gases through chimney for a given height of chimney.

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) Explain the working principle of the Locomotive Boiler with a neat and labelled sketch.   4

   b) What is once-through boiler ? Explain its working principle.   4

   c) What is circulation ? What is the difference between forced circulation and natural circulation ?   4

   d) How is boiler efficiency defined ? Enumerate the heat losses which occur in a boiler plant.   3

9. a) Define and explain 'equivalent evaporation'.   3

   b) Determine the height and the diameter of the chimney used to produce a draught for a boiler which has an average coal consumption of 1800 kg/h and flue gas formed per kg of coal fired are 14 kg. The pressure losses through the system are given below :

   Pressure loss in the fuel bed = 7 mm of water,

   Pressure loss at boiler flues = 7 mm of water

   Pressure loss in bends = 3 mm of water,

   Pressure loss in chimney = 3 mm of water.

   The temperatures of ambient air and flue gases are 35°C and 310°C respectively. Assume actual draught as 80% of theoretical draught.   6

c) The following readings were obtained during a boiler trail of 6 hrs duration :

Mean steam pressure = 12 bar;

Mass of steam generated = 40000 kg;

Mean dryness fraction = 0·85;

Mean feed water temperature = 30°C,

Coal used = 4000 kg,

Calorific value of coal = 33400 kJ/kg.

Calculate

  i)   factor of equivalent evaporation

  ii) equivalent evaporation from and at 100°C

  iii) efficiency of the boiler.   6

10. a) Derive an expression for the efficiency of Otto cycle.   3

    b) In a test of a 4-cylinder, 4-stroke engine of 75 mm bore and 100 mm stroke, the following results were obtained full throttle at a particular constant speed with fixed setting of fuel supply of 6 kg/h.

    B.P. with all cylinder working = 15·6 kW

    B.P. with cylinder No. 1 cut-out = 11·1 kW

    B.P. with cylinder No. 2 cut-out = 11·03 kW

    B.P. with cylinder No. 3 cut-out = 10·88 kW

    B.P. with cylinder No. 4 cut-out = 10·66 kW

    If the calorific value of fuel is 836000 kJ/kg and clearance volume is 0·0001 m^3, calculate —

    i)   mechanical efficiency

    ii) indicated thermal efficiency

    iii) air standard thermal efficiency.   6

c) A 6-cylinder diesel engine operates on 4-stroke cycle. The bore of each cylinder is 95 mm and stroke is 120 mm. Speed of engine is 2400 r.p.m.; Orifice diameter = 30 mm; Coefficient of discharge, C_d = 0·62; Time to consume 100 c.c. diesel = 19·3 sec; Fuel density = 0·831 gm/c.c.; Density of air = 1·17 kg/m^3; Manometric water head = 197 mm; Brake Drum = 300 mm; Rope diameter = 20 mm; Brake load = 56 kg; Calculate —

    i) brake power

    ii) brake thermal efficiency if calorific value of diesel is 43000 kJ/kg

    iii) volumetric efficiency

    iv) Brake mean effective pressure. 6

11. A power plant producing 120 MW of electricity has steam condition at boiler outlet as 100 bar, 500°C; and the condenser pressure is 0·1 bar. The boiler efficiency is 90%. The feed water temperature at the boiler inlet is 160°C. The steam generator has risers in the furnace wall 40 m high and unheated downcomers. The quality at the top of the riser is 8% and a minimum exist velocity of mixture leaving the riser and entering the drum is required to be 2 m/s. The risers

have 60 mm OD and 3 mm wall thickness. Neglecting any pressure drop and heat loss as well as the pump work, when boiler consumes coal of calorific value 25·7 MJ/kg; Calculate —

i)   the steam generation rate

ii)   the evaporation factor

iii) the circulation ratio

iv)   the pressure head available

v)   the number of risers required.

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