

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

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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 any *ten* of the following :

$$10 \times 1 = 10$$

- i) Natural circulation type boiler runs on the principle of
 - a) differential density of hot and cold water
 - b) differential density of hot and cold gases at the chimney
 - c) natural draught system with chimney
 - d) none of these.
- ii) Water required for attemperation is taken from
 - a) boiler drum
 - b) feed pump
 - c) economizer
 - d) either (a) or (b).

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- iii) Supercritical boilers are
 - a) fire tube boilers
 - b) water tube boiler
 - c) a combination of above two
 - d) once-trough boilers.
- iv) The ratio of indicated thermal efficiency to the corresponding air standard efficiency is called
 - a) net efficiency
 - b) relative efficiency
 - c) efficiency ratio
 - d) cycle efficiency.
- v) A thermal power plant works on
 - a) Carnot cycle
 - b) Joule cycle
 - c) Rankin cycle
 - d) Otto cycle.
- vi) A closed cycle gas turbine works on
 - a) Carnot cycle
 - b) Ericsson cycle
 - c) Rankin cycle
 - d) Brayton's cycle.
- vii) The main function of condenser is to
 - a) create vacuum
 - b) condense steam to water for reuse
 - c) maintain vacuum
 - d) all of these.

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- viii) A carburetor is used to supply
- petrol, air and lubricating oil
 - petrol and lubricating oil
 - air and diesel
 - petrol and air.
- ix) For the same compression ratio the efficiency of otto engine is
- more than efficiency of diesel cycle
 - less than the efficiency of diesel cycle
 - equal to the efficiency of diesel cycle
 - none of these.
- x) In SI engine, high voltage for spark plug is developed using
- battery
 - ignition coil
 - distributor
 - carburetor.
- xi) The ratio of work done per cycle to the swept volume in case of IC engine is called
- compression index
 - mean effective pressure
 - compression ratio
 - volumetric efficiency.

- xii) Temperature of steam at super heater outlet of a modern thermal power plant is in the range of
- 700°C
 - 550°C
 - 400°C
 - 250°C.
- xiii) Petrol commercially available in India for passenger cars has octane number in the range
- 40 to 50
 - 60 to 70
 - 80 to 85
 - 95 to 100.
- xiv) Compounding of steam turbine is done for
- reducing the workdone
 - increasing the rotor speed
 - reducing the rotor speed
 - balancing the turbine.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

- Briefly explain fuel characteristics of spark ignition engine.
- What are the advantages of 2-s engine over 4-s engine ? What do you mean by knocking in I.C. engines ? $3 + 2$
- Differentiate between boiler accessories and boiler mountings with example.
- A gas turbine unit has a pressure ratio of 6 : 1 and maximum cycle temperature is 610°C. The isentropic efficiencies of the compressor and turbine are 0.80 and 0.82 respectively. Calculate the power output in kilowatts of an electric generator gearing to the turbine when air enters the compressor at 15°C at the rate of 16 kg/s. Take $C_p = 1.005 \text{ kJ/kgK}$ $\gamma = 1.4$ for the compression process and $C_p = 1.11 \text{ kJ/kgK}$ $\gamma = 1.33$ for the expansion process.

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6. Describe briefly the working principle of an EST with a neat sketch.
7. A boiler produces 2000 kg of dry & saturated steam per hour at 10 bar and feed water is heated by an economiser to 110°C. 225 kg of coal of calorific value 30,100 kJ/kg are fired per hour of which 10% remain unburnt. Find
 - a) Thermal efficiency of boiler alone
 - b) Thermal efficiency of boiler and economiser.

Given that condenser pressure is 0.1 bar.

GROUP - C

(Long Answer Type Questions)

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

8. a) What is the object of supercharging ? Why is it more beneficial in a CI engine compared to a SI engine ?
- b) In an air standard diesel cycle, the compression ratio is 16 and at the beginning of isentropic compression the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature is 1480°C at the end of constant pressure process. Calculate —
 - i) the cut-off ratio
 - ii) the heat supplied per kg of air
 - iii) the cycle efficiency
 - iv) the mcp. $7 + 8$

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9. A steam power plant equipped with regenerative as well as reheat arrangement is supplied with steam to the HP turbine at 80 bar 470°C. For feed water heating a part of steam is extracted at 7 bar and remainder of the steam is reheated to 350°C in a reheater and then expanded in a LP turbine down to 0.035 bar. The steam supplied by the boiler is 50 kg/s.

Determine

- a) Amount of steam bled off for feed heating
- b) Amount of steam supplied to LP turbine
- c) Heat supplied in the reheater
- d) Cycle efficiency
- e) Power developed by steam.
10. a) Define the term 'circulation ratio' in a water tube boiler. What is the normal range of this ratio ?
- b) What is an 'Electrostatic' precipitator ? Briefly describe its function and principle of operation.
- c) State five advantages of a gas turbine plant over a steam turbine plant.
- d) What are the common combustion generated pollutants from a diesel engine ? $3 + 5 + 5 + 2$
11. a) In an impulse turbine the fixed nozzle angle is α , the blades are equiangular and the blade velocity coefficient is k . Show that maximum efficiency is $[(1+k)\cos^2 \alpha]/2$.

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- b) A reaction turbine uses 9000 kg of steam per hour. At one point in the turbine, the blades are 20 mm high and discharge angle of both fixed and moving blades is 20° . The steam leaves the fixed blade at pressure of 0.32 N/mm^2 with a dryness fraction of 0.95 and a velocity of 120 m/s. Assume the ratio of axial velocity of flow to blade velocity as 0.70 at entry to and 0.76 at exit from the moving blade, assuming a tip of leakage of 6% of the total steam, determine

i) Speed of the turbine in rev/minute

ii) Power developed. 5 + 10

12. a) State and explain different methods of compounding.
 b) What are the methods of governing a steam turbine? Describe any one method of governing of steam turbine.
 c) Steam is expanded in a set of nozzle from 10 bar and 200°C to 5 bar. What type of nozzle is it? Neglecting the initial velocity find the minimum area of the nozzle required to allow a flow of 3 kg/s under given conditions. Assume expansion of steam to be isentropic.

5 + 5 + 5

13. Write short notes on any *three* of the following : 3 × 5

- a) Morse test
- b) Knocking of IC engine
- c) Natural draught
- d) Intercooling gas turbine
- e) Locomotive boiler
- f) Cyclone separator.

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