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B

# B.Tech. Degree V Semester Examination November 2015

## ME 504 THERMAL ENGINEERING

*(2006 scheme)*

Time : 3 Hours Maximum Marks : 100

### PART A

(Answer *ALL* questions)

(8 × 5 = 40)

I. (a) Derive an expression for air standard efficiency of an otto cycle.

(b) Sketch and explain valve timing diagram for four stroke diesel engine.

(c) Briefly explain super charging and turbo charging in IC engines.

(d) Write notes on octane number and cetane number.

(e) Explain supersaturated flow in steam nozzle.

(f) Explain pressure compounding in steam turbines.

(g) Explain the methods for increasing efficiency of gas turbine plants.

(h) Explain different types of combustion chambers in gas turbine.

### PART B

(4 × 15 = 60)

II. A four stroke petrol engine 80 mm bore, 100 mm stroke, is tested at full throttle at a constant speed. The fuel supply is fixed at 0.068 kg/min and the plugs of the four cylinders are successively short circuited without change of speed, brake torque being correspondingly adjusted. The brake power measurements are the following. (15)

| | | |
|---|---|---|
| With all cylinders firing | = | 12.5 kW |
| With cylinder no.1 cut-off | = | 9 kW |
| With cylinder no.2 cut-off | = | 9.15 kW |
| With cylinder no.3 cut-off | = | 9.2 kW |
| With cylinder no.4 cut-off | = | 9.1 kW |

Determine I.P of the engine under these conditions. Also determine the indicated thermal efficiency. Calorific value of the fuel is 44,100 kJ/kg. Compare this efficiency with air standard value. Clearance volume of one cylinder is $70 \times 10^3$ mm$^3$.

**OR**

III. An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical diesel cycle. The initial pressure and temperature of air used are 1 bar and $27°C$. The cut-off is 8% of the stroke. Determine: (15)

(i) Pressures and temperatures at all salient points.
(ii) Theoretical air standard efficiency.
(iii) Mean effective pressure.
(iv) Power of the engine if the working cycles per minute are 380.

Assume that compression ratio is 15 and working fluid is air. Consider all conditions to be ideal.

**(P.T.O.)**

IV. (a) Explain working of stratified charged engine. (5)

(b) Explain any two method of governing IC engine. (10)

**OR**

V. (a) Explain different types of combustion chambers in SI engine. (10)

(b) Write notes on HUCR. (5)

VI. A steam nozzle is supplied with steam at 15 bar, $450°C$ and discharges steam at 1 bar. If the divergent portion of the nozzle is 80 mm long and the throat diameter is 6 mm, determine the cone angle of the divergent portion. Assume 15% of the total available enthalpy drop is lost in friction in the divergent portion. Also determine the velocity and temperature of steam at throat. (15)

**OR**

VII. A simple impulse turbine has a mean blade speed of 200 m/s. The nozzles are inclined at 20° to the plane of rotation of the blades. The steam velocity from the nozzles is 600 m/s. The turbine uses 3500 kg/hr of steam. The absolute velocity at exit is along the axis of the turbine. Determine : (15)

(i) The inlet and exit angles of the blades.
(ii) The power output of the turbine.
(iii) The diagram efficiency.
(iv) The axial thrust (per kg of steam per second).

VIII. Find the required air-fuel ratio in a gas turbine whose turbine and compressor efficiencies are 85% and 80% respectively. Maximum cycle temperature is 875°C. The working fluid can be taken as air ($Cp = 1.0\ kJ/kg.K, \gamma = 1.4$) which enters the compressor at 1 bar and $27°C$. The pressure ratio is 4. The fuel used has calorific value of 42000 kJ/kg. There is a loss of 10% of calorific value in the combustion chamber. (15)

**OR**

IX. A centrifugal compressor compresses 4.8 $m^3/s$ of air from 1 bar and 20°C to 1.5 bar. The index of compression is 1.5. The flow velocity at inlet and outlet of the machine is the same and is equal to 65 m/s. The inlet and outlet impeller diameters are 0.32 m and 0.62 m respectively. The compressor rotates at 8000 rpm. Calculate : (15)

(i) The blade angles at inlet and outlet of the impeller.
(ii) The absolute angle at the tip of the impeller
(iii) The breadth of the blade at inlet and outlet.

It may be assumed that no diffuser is employed and whole pressure increase takes place in the impeller and the blades have negligible thickness.

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