00244

B.Tech. MECHANICAL ENGINEERING (BTMEVI)

Term-End Examination

June, 2014

BIME-013 : TURBO MACHINES

Time : 3 hours *Maximum Marks : 70*

Note : *(i) Answer **any seven** questions.*

*(ii) **All** questions carry **equal** marks.*

*(iii) Use of scientific calculator is **permitted.***

1. (a) How does actual gas turbine cycle differ from the theoretical cycle ? 5+5
   (b) What are the requirements of combustion chamber of a gas turbine ?

2. What are the essential components of a gas turbine working on a closed cycle ? Illustrate your answer with the help of a neat sketch. Derive an expression for the ideal thermal efficiency of such a plant. 10

3. Show by method of dimensional analysis that the resistance R to the motion of a sphere of diameter D moving with uniform velocity V through a fluid leaving density ρ and viscosity μ may be expressed as $R = (\rho D^2 V^2)\, \phi \left(\frac{\mu}{\rho V D} \right)$. 10

4. A centrifugal pump has the following characteristics : 10
outer diameter of impeller = 800 mm,
width of impeller vanes at outlet = 100 mm,
angle of impeller vanes at outlet = 40°,
The impeller runs at 550 rpm and delivers 0.98 cubic metres of water per second under an effective head of 35 m. A 500 kW motor is used to drive the pump. Determine the manometric, mechanical and overall efficiencies of the pump. Assume water enters the impeller vanes radially at inlet.

5. A single - stage single - acting air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke are 30°C and 1 bar. The bore and stroke of the compressor are 100 mm and 150 mm respectively. The clearance is 3% of the swept volume. Assuming the index of compression and expansion to be 1.3, find : 10
(a) Volumetric efficiency of the compressor,
(b) Power required if the mechanical efficiency is 85%, and
(c) Speed of the compressor (rpm).

6. What is a centrifugal compressor ? How does it differ from an axial flow compressor ? 10

7. In a constant pressure open cycle gas turbine air enters at 1 bar an 20°C and leaves the compressor at 5 bar. Using the following data. Temperature of gases entering the turbine = 680°C, pressure loss in the combustion chamber = 0.1 bar, $\eta_{compressor} = 85\%$, $\gamma = 1.4$ and C_p = 1.024 kJ/kg K for air and gas, find : 10

(a) The quantity of air circulation if the plant develops 1065 kW,
(b) Heat supplied per kg of air circulation,
(c) The thermal efficiency of the cycle.

8. In a gas turbine the compressor is driven by the high pressure turbine. The exhaust from the high pressure turbine goes to a free low pressure turbine which runs the load. The air flow rate is 20 kg/sec. and the minimum and maximum temperature are 300 K and 1000 K respectively. The compressor pressure ratio is 4. Calculate the pressure ratio of the low pressure turbine and the temperature of exhaust gases from the unit. The compressor and turbine are isentropic. C_p of air and exhaust gases = 1 kJ / kg K, and $\gamma = 1.4$. **10**

9. (a) How are the steam turbines classified ? **5+5**
(b) Discuss the advantages of a steam turbine over the steam engines.

10. The velocity of steam exiting the nozzle of the impulse stage of a turbine is 400 m/s. The blades operate close to the maximum blading efficiency. The nozzle angle is 20°. Considering equiangular blades and neglecting blade friction, calculate for a steam flow of 0.6 kg/s, the diagram power and the diagram efficiency. **10**