



B.E/B.TECH DEGREE EXAMINATIONS: NOV/DEC 2024

(Regulation 2018)

Fifth Semester

MECHANICAL ENGINEERING

U18MET5004: Turbo Machines

COURSE OUTCOMES

- CO1:** Apply the Principles of turbo machines
CO2: Design and estimate different parameters for centrifugal fans
CO3: Design and analyze flow parameters in blowers
CO4: Solve problems on centrifugal compressors
CO5: Design simple stage problems in axial flow compressors
CO6: Calculate and analyze flow parameters in radial flow gas turbines

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 2 = 20 Marks)

(Answer not more than 40 words)

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|--|-----|-------------------|
| 1. Define specific speed of turbomachine. | CO1 | [K ₁] |
| 2. Compare turbine and compressor. | CO1 | [K ₂] |
| 3. List the methods to reduce the fan noise. | CO2 | [K ₂] |
| 4. Differentiate between Diffuser and volutes. | CO2 | [K ₂] |
| 5. Mention the elements of a centrifugal compressor. | CO3 | [K ₂] |
| 6. Define slip factor of a centrifugal compressor. | CO3 | [K ₁] |
| 7. Illustrate the concept of work done factor in an axial flow compressor. | CO4 | [K ₂] |
| 8. Define enthalpy and entropy. | CO4 | [K ₁] |
| 9. State the concept of stage velocity diagram. | CO5 | [K ₂] |
| 10. Write the basic principles to be followed while designing of blades. | CO6 | [K ₂] |

Answer any FIVE Questions:-

PART B (5 x 16 = 80 Marks)

(Answer not more than 400 words)

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|--|----|-----|-------------------|
| 11. a) Explain in detail the stage velocity triangles of turbomachinery. | 10 | CO1 | [K ₂] |
| b) Discuss in detail the classification of fluid machinery. | 06 | CO1 | [K ₂] |

12. a) A centrifugal blower with a radial impeller produces a pressure equivalent to 100 cm column of water. The pressure and temperature at its entry are 0.98 bar and 310 K. The electric motor driving the blower runs at 3000 rpm. The efficiencies of the fan and drive are 82% and 88% respectively. The radial velocity remains constant and has a value of $0.2u_2$. The velocity at the inlet eye is $0.4u_2$. If the blower handles $200 \text{ m}^3/\text{min}$ of air at the entry conditions, determine:
- power required by the electric motor,
 - impeller diameter,
 - inner diameter of the blade ring,
 - air angle at entry,
 - impeller widths at entry and exit,
 - number of impeller blades, and
 - the specific speed.
13. a) Explain with a neat sketch of centrifugal blower components and write the design parameters. 08 CO3 [K₃]
- b) Determine the pressure ratio developed and the power required to drive a centrifugal air compressor (impeller diameter = 45 cm) running at 7200 rpm. Take zero swirl at the entry and $T_{01} = 288 \text{ K}$. Assume isentropic flow with no shock, and radially tipped impeller blades. 08 CO3 [K₂]
14. a) Air enters the inducer blades of a centrifugal compressor at $P_{01}=1.02 \text{ bar}$, $T_{01} = 335 \text{ K}$. The hub and tip diameters of the impeller eye are 10 and 25 cm respectively. If the compressor runs at 7200 rpm and delivers 5.0 kg/s of air, determine the air angle at the inducer blade entry and the relative Mach number. If IGVs are used to obtain a straight inducer section, determine the air angle at the IGVs exit and the new value of the relative Mach number. 16 CO4 [K₃]
15. a) Explain with a neat sketch of pressure and velocity variation for an axial flow compressor stage. 08 CO4 [K₃]
- b) Draw and explain the energy flow diagram for an axial flow compressor stage. 08 CO5 [K₂]
16. a) An IFR turbine impulse stage with cantilever blades has a flow coefficient of 0.4 and develops 100 kW with a total-to-total efficiency of 90% at 12000 rpm. If the flow rate of air is 1.0 kg/s at an entry temperature of 400 K, determine the rotor diameters and air angles at the entry and exit, the nozzle exit air angle and the stagnation pressure ratio across the stage. Take $d_3 = 0.8 d_2$, zero exit swirl and constant meridional velocity. 10 CO5 [K₃]
- b) Discuss the elements of a Radial turbine stage. 06 CO6 [K₂]
