GUJARAT TECHNOLOGICAL UNIVERSITY

BE-7 SEMESTER – OLD PAPER – S22 TO W24 – QUESTION BANK

Subject Name & Code:

Turbo Machines- 3171927

Unit 1: Introduction to Turbomachineries

Repeated Questions:

1. **Define a turbomachine and classify different types.** *(W'24-Q1(a)-03, S'22-Q1(a)-03)*
2. **Differentiate between Turbo machines and Positive Displacement machines.** *(S'23-Q1(c)-07, W'22-Q1(a)-03)*
3. **Explain the significance of dimensionless parameters: Flow coefficient, Head coefficient, and Power coefficient.** *(S'22-Q1(c)-07, W'23-Q1(c)-NR, S'23-Syllabus)*
4. **What are geometric, kinematic, and dynamic similarities?** *(S'23-Q1(a)-03, W'22-Q1(c)-07)*
5. **Differentiate between Fans, Blowers, and Compressors.** *(W'24-Q1(b)-04, W'23-Q1(b)-NR)*

Other Important Questions:

6. **Briefly classify turbomachines.** *(S'22-Q1(b)-04)*
7. **Define driving and driven types of turbomachines.** *(W'23-Q1(a)-NR)*
8. **Discuss noise issues for blowers and fans.** *(W'23-Q1(b)-NR, S'22-Q5(a)-03)*

Unit 2: Axial Flow Turbines & Radial Flow Turbines

Repeated Questions:

1. **Explain the necessity of compounding in axial flow turbines. Classify and explain multi-stage velocity compounded impulse turbine with a neat sketch.** *(S'22-Q2(c)-07, W'24-Q2(c)-07, W'23-Q2(b)-NR)*
2. **Draw and explain velocity triangles for:**
   - **A 50% reaction stage.** *(S'23-Q3(a)-03)*
   - **An inward flow radial (IFR) turbine. Show that for a 90° IFR turbine, the stage loading coefficient is unity.** *(W'23-Q2(c)-07, W'24-Q3(a)-03)*
3. **Define and explain "total to total efficiency" and "total to static efficiency".** *(W'22-Q4(a)-03, S'22-Q2(a)-03, W'24-Q2(b)-04)*
4. **Define the degree of reaction. Derive an expression for it (for axial or radial machines).** *(W'22-Q2(c)-07, W'24-Q3(a)-03, S'23-Q3(b)-04)*
5. **Explain the condition for maximum utilization factor or blade efficiency for an impulse turbine with equiangular blades.** *(S'23-Q2(c)-07)*
6. **Draw a Mollier (h-s) diagram for a radial (90° IFR) turbine.** *(W'24-Q3(b)-04)*
7. **List the aerodynamic losses that occur in a radial turbine stage.** *(S'23-Q2(b)-04, W'22-Q5(b)-04, S'22-Q5(b)-04)*

Other Important Questions:

8. **Draw superimposed velocity triangles of axial flow turbines with proper notations.** *(W'23-Q2(a)-03)*
9. **Explain blade to gas speed ratio for an axial flow turbine.** *(W'22-Q3(a)-03, W'23-Q3(a)-NR)*
10. **Explain stage terminal velocity, stage losses, effect of exhaust diffuser, and degree of reaction in a radial turbine.** *(S'22-Q2(b)-04)*
11. **Why are radial gas turbines not suitable for large power applications?** *(W'22-Q2(a)-03, W'24-Q2(a)-03)*
12. **Give five applications of partial admission turbines.** *(S'23-Q3(a)-03)*
13. **What is creep? How does it affect gas turbine operation? List methods of cooling gas turbine blades.** *(S'23-Q3(c)-07)*
14. **Energy flow diagram for the impulse stage of an axial turbine.** *(S'23-Q3(c)-07)*

Numerical Problems from this Unit:

15. **Impulse Turbine Numerical:** The data pertaining to an impulse turbine is as follows: Steam velocity = 500 m/s, blade speed = 200 m/s, Exit angle of moving blade = 20°. Neglecting friction, determine: (a) inlet angle of moving blade, (b) exit velocity and direction, (c) work done per kg of steam, (d) axial thrust and power for 5 kg/s, (e) blade efficiency. *(W'23-Q2(c)-07)*
16. **50% Reaction Stage Numerical:** A 50% reaction stage axial flow turbine has a mean blade diameter of 0.60 m. The maximum utilization factor is 0.85 and steam flow rate is 12 kg/s. Calculate the inlet and outlet absolute velocities and power developed if the speed is 2500 rpm. *(S'22-Q2(c)-07)*
17. **90° IFR Turbine Numerical (Detailed):** A ninety-degree IFR turbine stage has data: pressure ratio $p_{01}/p_3 = 3.5$, exit pressure 1 bar, stagnation inlet temperature 650°C, speed ratio $\sigma = 0.66$, rotor diameter ratio $d_3/d_2 = 0.45$, speed N=16000 rpm, nozzle exit angle $a_2 = 20°$, nozzle efficiency $\eta_N = 0.95$, rotor width at entry $b_2 = 5$ cm. Assume constant meridional velocity and axial exit. Determine: (a) rotor diameter, (b) rotor blade exit air angle, (c) mass-flow rate, (d) hub/tip diameters at exit, (e) power developed, (f) total-to-static efficiency. *(S'23-Q2(c)-07)*

Unit 3: Axial Flow Compressors

Repeated Questions:

1. **With a suitable sketch, explain the working principle of an axial flow compressor and stage velocity triangles.** *(S'22-Q3(c)-07)*
2. **Draw and explain the "energy flow diagram" for an axial flow compressor stage.** *(W'22-Q4(a)-03, S'22-Q3(a)-03)*
3. **Define the Work Done Factor for an axial flow compressor.** *(S'22-Q3(a)-03)*
4. **Explain supersonic and transonic stages in an axial flow compressor.** *(S'22-Q3(b)-04)*
5. **Draw a sketch of a two-stage axial flow compressor with inlet guide vanes and explain it.** *(S'23-Q4(a)-03, S'22-Q3(b)-04, W'23-Q3(b)-NR)*
6. **What is surging in axial-flow compressors? What are its effects?** *(S'23-Q4(b)-04)*
7. **Obtain an expression for the degree of reaction of an axial flow compressor in terms of rotor blade angles, axial velocity, and blade speed (assuming constant axial velocity).** *(W'22-Q3(c)-07)*
8. **Plot the h-S diagram for an axial flow compressor and define overall total-to-total isentropic efficiency.** *(W'23-Q3(c)-NR)*

Other Important Questions:

9. **Show graphically the variation of efficiency with specific speed for an axial flow compressor.** *(W'22-Q3(b)-04)*
10. **Explain internal and mechanical losses in an axial flow compressor.** *(W'23-Q3(b)-NR)*
11. **List various advantages and disadvantages of an axial flow compressor.** *(W'24-Q3(b)-04)*
12. **Why are axial flow compressors ideal for constant load applications?** *(W'24-Q3(c)-07)*

Numerical Problems from this Unit:

13. **Axial Compressor Stage Numerical:** An axial compressor stage has data: Temperature and pressure at entry 300K, 1.0 bar, Degree of reaction 50%, Mean blade ring diameter 36 cm, Rotational speed 18000 rpm, Blade height at entry 6 cm, Air angles at rotor and stator exit 25°, Axial velocity 180m/s, Work-done factor 0.88, Stage efficiency 85%, Mechanical efficiency 96.7%. Determine: (a) Air angles at rotor and stator entry, (b) mass flow rate, (c) power required, (d) loading coefficient, (e) pressure ratio. *(S'23-Q4(c)-07)*
14. **Axial Compressor Multi-stage Numerical:** An axial flow compressor draws air at 20°C and delivers it at 50°C. Assuming 50% reaction, calculate the velocity of flow if blade velocity is 100 m/s. With work factor 0.85 and angles a=10°, b=40°, calculate the number of stages. *(S'22-Q3(c)-07)*
15. **Axial Compressor Numerical:** The following data refers to an axial flow compressor: Relative flow angle at inlet, $\beta_1 = 60°$, turning angle = 30°, $\Delta C_w = 100$ m/s, degree of reaction 50%, speed 36000 rpm, mean diameter = 140 mm, inlet pressure = 2 bar, inlet temperature = 57°C. Find air flow angle α_1, pressure rise, mass flow rate (blade height=20mm), and power. *(W'23-Q3(c)-07)*

Unit 4: Centrifugal Compressors

Repeated Questions:

1. **Explain the phenomenon of slip in centrifugal compressors and the significance of the slip factor in deciding the number of vanes.** *(W'22-Q3(c)-07, S'22-Q4(c)-07, W'23-Q4(c)-07, W'24-Q4(c)-07)*
2. **Describe the principle, construction, and working of a centrifugal compressor with a sketch showing principal parts.** *(S'22-Q4(b)-04, W'24-Q4(a)-03, W'24-Q4(b)-04)*
3. **What is the function of a diffuser? Explain vaneless and vaned diffusers used in centrifugal compressors.** *(W'23-Q4(c)-NR, S'22-Q4(b)-04)*
4. **Explain the influence of inlet and outlet blade angles on the performance of a centrifugal compressor.** *(S'22-Q4(a)-03)*
5. **List and explain the different types of losses in a centrifugal compressor.** *(S'22-Q4(a)-03, W'23-Q4(b)-NR)*

Other Important Questions:

6. **Discuss the general (Ideal) characteristics of a centrifugal compressor.** *(W'23-Q4(b)-NR)*
7. **Show slip and velocity distribution using the velocity triangle of a centrifugal compressor.** *(W'23-Q4(a)-NR)*
8. **What is the purpose of inlet guide vanes and inducer blades in a centrifugal compressor?** *(W'22-Q4(b)-04)*
9. **What is a no-slip condition? Define slip factor.** *(W'24-Q4(a)-03)*

Numerical Problems from this Unit:

10. **Centrifugal Compressor Numerical (Power & Pressure Ratio):** 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 entry and $T_{01} = 288$ K. Assume isentropic flow, no shock, and radially tipped impeller blades. *(S'23-Q5(c)-07)*
11. **Centrifugal Compressor Numerical (Detailed):** A centrifugal compressor running at 1440 rpm handles air at 101 kPa and 20°C and compresses it to a pressure of 6 bar isentropically. The inner and outer diameters of the impeller are 14 cm and 25 cm. The inlet blade width is 2.5 cm. Blade angles are 16° and 40° at entry and exit. Calculate mass flow rate, degree of reaction, power input, and blade width at outlet. *(S'22-Q4(c)-07)*
12. **Centrifugal Compressor/Fan Numerical:** A centrifugal compressor raises the static pressure of air by 14cm of water while running at 650 RPM and consuming 85 metric HP. Intake conditions: P=75 cm of Hg, T=25°C. Mass flow rate is 260 kg/min. Find the exit static pressure and the volume flow rate in m³/min. *(W'24-Q4(c)-07)*

Unit 5: Fans and Blowers

Repeated Questions:

1. **Explain in detail about the flow analysis in impeller blades, volute, and diffusers in fans and blowers.** *(W'22-Q5(b)-04, S'22-Q5(c)-07)*
2. **Explain the volumetric efficiency of fans and blowers. What factors govern it?** *(W'22-Q5(c)-07, S'22-Q5(a)-03, W'23-Q5(a)-NR)*
3. **State the types of Centrifugal Fans. Explain any one briefly.** *(S'23-Q5(b)-04, S'22-Q5(b)-04)*
4. **Define for fans: Static efficiency, Total efficiency, and Volumetric efficiency.** *(W'23-Q5(a)-03)*
5. **List and explain different losses in fans.** *(W'23-Q5(b)-04, S'22-Q5(a)-03)*
6. **Explain noise problems in fans and blowers.** *(S'22-Q5(a)-03, W'24-Q5(a)-03)*
7. **Draw and explain the performance characteristics (Pressure coefficient vs. Flow coefficient) for different types of centrifugal impellers.** *(W'22-Q5(c)-07)*

Other Important Questions:

8. **Classify fans and blowers.** *(W'23-Q5(a)-03, W'24-Q5(a)-NR)*
9. **List methods to reduce surging in axial fans.** *(W'24-Q5(a)-03)*
10. **Draw a sketch of an axial flow ducted fan without guide vanes and highlight its parts.** *(W'24-Q5(b)-04)*
11. **Explain theoretical and actual characteristics of a centrifugal fan.** *(W'23-Q5(b)-04)*

Unit 6: Use of CFD for Turbo machinery Analysis and Design

Repeated Questions:

1. **What is the use of CFD for Turbo machinery analysis and design? Explain its application in detail.** *(W'22-Q5(a)-03, W'23-Q5(c)-07, W'24-Q5(c)-07)*
2. **Explain the advantages, disadvantages, and limitations of CFD from a turbomachinery point of view.** *(W'23-Q5(c)-07, W'24-Q5(c)-07)*

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