Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2022**

**Subject Code:3150102 Date:09-01-2023**

**Subject Name:Fundamentals of Turbomachines**

**Time:10:30 AM TO 01:00 PM Total Marks:70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

| | | | **MARKS** |
|---|---|---|---|
| **Q.1** | **(a)** | Differentiate between an impulse turbine and reaction turbine. | **03** |
| | **(b)** | Define an inward flow machine and outward flow machine. Give example of each. | **04** |
| | **(c)** | Draw and explain, h-s diagram of an axial turbine stage. | **07** |
| **Q.2** | **(a)** | Differentiate between pump, blower and compressor. | **03** |
| | **(b)** | For an axial turbine Prove that, $Cy_2 + Cy_3 = Wy_2+Wy_3$ | **04** |
| | **(c)** | Draw and explain velocity triangle for a two stage velocity compounded turbine with maximum utilization factor. | **07** |
| | | **OR** | |
| | **(c)** | Define and write the expressions of: rotor loss coefficient, nozzle loss coefficient, flow coefficient and stage loading coefficient. | **07** |
| **Q.3** | **(a)** | Explain surging in an axial compressor stage. | **03** |
| | **(b)** | Define Axial compressor. Draw and explain pressure & velocity variation through a compressor stage. | **04** |
| | **(c)** | A 10 stage axial flow compressor provides an overall pressure ratio of 5:1 with an overall isentropic efficiency of 87%. When the temperature of air at inlet is 15ºC. The work is equally divided between the stages. A 50% reaction is used with a blade speed of 210 m/s and a constant axial velocity of 170 m/s. Estimate the blade angles. Assume a work done factor of 1. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Explain the need of gas turbine blade cooling. | **03** |
| | **(b)** | Write a matching procedure for turbomachines. | **04** |
| | **(c)** | With the help of diagram, explain the various components of centrifugal compressor. | **07** |
| **Q.4** | **(a)** | Explain briefly the flow properties change in the reaction turbine stage. | **03** |
| | **(b)** | Explain the methods of turbine blade cooling with neat sketches. | **04** |
| | **(c)** | In a single-stage impulse turbine the nozzle discharges the fluid on to the blades at an angle of 65º to the axial direction and the fluid leaves the blades with an absolute velocity of 300 m/s at an angle of 30º to the axial direction. If the blades have equal inlet and outlet angles and there is no axial thrust, estimate the blade angle, power produced per kg/s of the fluid and the blade efficiency. | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Draw the variation in degree of reaction for an axial compressor stage with the change in blade angles. | **03** |
| | **(b)** | Explain the importance of volute casing in a compressor stage. | **04** |

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|---|---|---|---|
| | **(c)** | Draw velocity triangle for an outward flow radial turbine stage. | **07** |
| **Q.5** | **(a)** | Discuss the types of impellers used in a centrifugal compressor. | **03** |
| | **(b)** | What is slip factor? What is its effect on flow and pressure ratio in the stage? Derive the Stodola's relation for slip factor | **04** |
| | **(c)** | A centrifugal compressor under test gave the following data:<br>Speed : 11,500 rev/min<br>Inlet total head temperature : 21ºC<br>Outlet and inlet total head pressure : 4 bar, 1 bar<br>Impeller dia : 75 cm<br>If the slip factor is 0.92, what is the compressor efficiency? | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Define equilibrium running point and equilibrium running line? | **03** |
| | **(b)** | Explain the procedure to find equilibrium running point for on performance charts of compressor and turbine. | **04** |
| | **(c)** | Define degree of reaction. Derive the important relations/ conditions for an impulse stage based on value of degree of reaction. | **07** |

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