

**R18**

**Code No: 157EA**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**B. Tech IV Year I Semester Examinations, July/August - 2023**

**TURBO MACHINERY  
(Mechanical Engineering)**

**Time: 3 Hours**

**Max.Marks:75**

**Note:** i) Question paper consists of Part A, Part B.

ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.

iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

**PART – A**

**(25 Marks)**

- a) What is static and stagnation conditions of Turbo machines? [2]
- b) Define turbomachine? Write the principal components of turbo machines. [3]
- c) Distinguish between radial and mixed flow machines. [2]
- d) What do you mean by Net Positive Suction head? [3]
- e) Calculate the strength of shock wave when normal shock appears at  $M = 2$ . [2]
- f) Explain oblique shock where it occurs? [3]
- g) Define incidence in axial flow compressor. [2]
- h) Define blade force. [3]
- i) What do you mean by free vertex blade? [2]
- j) Define degree of reaction in axial flow gas turbines. [3]

**PART – B**

**(50 Marks)**

- 2.a) Explain the applications of first and second laws of thermodynamics to turbo machines in detail?
- b) Distinguish between positive displacement machines and Turbo machines in detail?[5+5]

**OR**

- 3.a) What is the role of entropy in the definition of second law of thermodynamics in detail?
- b) Classify the types of turbo machines and derive the Euler's expression for turbo machinery? [5+5]

- 4.a) Explain in detail the phenomenon of cavitation in pumps and also give the necessary precautions against cavitation in detail?
- b) Distinguish between Stanitz and Balje's slip factor in detail? [5+5]

**OR**

- 5.a) What are the effects of specific speed and shape number on axial and mixed flow machines in detail?

- b) Obtain the Euler's Energy transfer equation for rotating bodies. Explain [5+5]

- 6.a) What are the various stagnation properties that are encountered in compressible flow? Explain its applications in flow measurements?

- b) A centrifugal compressor runs at a speed of 15300 rpm and delivers 35 kg of air per second. Exit radius is 0.35m, relative velocity at exit is 100 m/s at an exit angle of  $75^\circ$ . Assume axial inlet and  $T_{01}=300$  K and  $p_{01}= 1$  bar. Calculate (i) the torque (ii) the power required to drive the compressor (iii) the ideal head developed (iv) the work done and (v) the exit total pressure [5+5]

**OR**

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7.a) What is the purpose of inlet guide vanes and inducer blades in centrifugal compressor? Explain briefly.

b) Give three formulas to calculate the slip factor. Derive Stanitz relation for the slip factor? [5+5]

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8.a) Why is it necessary to employ multi stage axial compressors to obtain moderate to high pressure ratios?

b) Calculate the pitot pressure of an air stream flowing at 415 m/sec. assume that the blow wave set up ahead of the tube is detached, the centre part being considered as a normal shock. Ambient pressure = 1.033 Kgf/cm<sup>2</sup> abs., static temperature = 23<sup>0</sup>C. [5+5]

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**OR**

9. At 1.02 bar and 35<sup>0</sup>C, air enters an axial flow compressor stage with an axial velocity of 185 m/s. The rotor stage has a tip diameter of 0.54 m and 0.51 m and rotates at a speed of 65200 RPM. The air enters the rotor and leaves the stator in the axial direction with no change in velocity or radius. The air is turned through 30<sup>0</sup> as it passes through rotor. Assuming constant specific heats and that the air enters and leaves the blade at the blade angles. Determine (a) mass flow rate (b) power requires (c) degree of reaction. [10]

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10.a) What is an actuator disc? How is this concept used to predict the axial velocity distribution in the actuator disc flow region? How does it differ from radial equilibrium theory?

b) Explain the different factors to be considered in the selection of blade materials of axial flow gas turbines. [5+5]

**OR**

11. Explain the following.

a) Secondary flow in the axial turbine and compressor cascades

b) Correlations of Soderberg and Ainley in turbine cascade analysis. [5+5]

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