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# B. M. S. College of Engineering, Bengaluru - 560019

**Autonomous Institute Affiliated to VTU**

## September / October 2023 Supplementary Examinations

**Programme: B.E.** **Semester: V**
**Branch: Aerospace Engineering** **Duration: 3 hrs.**
**Course Code: 20AE5DCBPR** **Max Marks: 100**
**Course: Basic Propulsion** **Date: 19.09.2023**

**Instructions**: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.





### UNIT - I

1. a) With the aid of schematic diagram and thermodynamic cycle, explain the working of Turbojet engine. Highlight its advantages and disadvantages. **10**

   b) Discuss the features of a ramjet engine **05**

   c) The effective jet exit velocity from a jet engine is 2700 m/s. The forward flight velocity is 1350m/s and the air flow rate is 78.6kg/s. Calculate i) thrust
   ii) Thrust power and iii) propulsive efficiency. **05**

**OR**

2. a) Define thrust and write the expression for thrust of air breathing engine with suitable sketches. **05**

   b) Define the following **05**
   i) Thermal efficiency of turbojet engine and propeller engine
   ii) Propeller efficiency
   iii) Propulsive efficiency and
   iv) Overall efficiency.

   c) An aircraft flies at a speed of 520 kmph at an altitude of 8000 m. The diameter of the propeller of an aircraft is 2.4 m and flight to jet speed ratio is 0.74. Find the following: Density is 0.525kg/$m^{3.}$ Assume fuel added is negligible compared to air flow rate. **10**
   (i) The rate of air flow through the propeller
   (ii) Thrust produced
   (iii) Specific thrust
   (iv) Specific impulse
   (v) Thrust power.

## UNIT - II

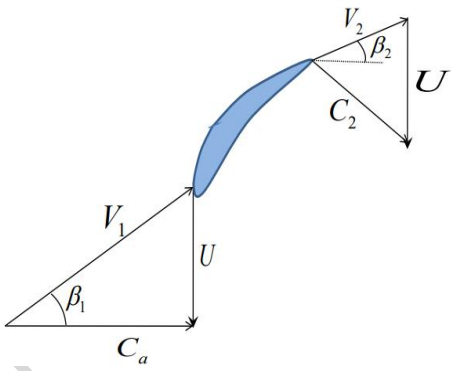
3. a) Describe briefly about the starting problem in a supersonic inlets and explain the phenomenon about shock swallowing. **10**

   b) Discuss the factors affecting combustion chamber design and write the working principle of a combustor. **10**

## UNIT - III

4. a) What are the factors affecting the stage pressure ratio in an axial compressors? **10**

   b) Air at 1.0 bar and 288 K enters an axial flow compressor with an axial velocity of 150 m/s. There are no inlet guide vanes. The rotor stage has a tip diameter of 60 cm and a hub diameter of 50 cm and rotates at 100 rps. 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 30.2° as it passes through the rotor. Assume an overall pressure ratio of 6 and a stage pressure ratio of 1.2. Find a) the mass flow rate of air, b) the power required to drive the compressor, c) the degree of reaction at the mean diameter, d) the number of compressor stages required if the isentropic efficiency is 0.85. **10**

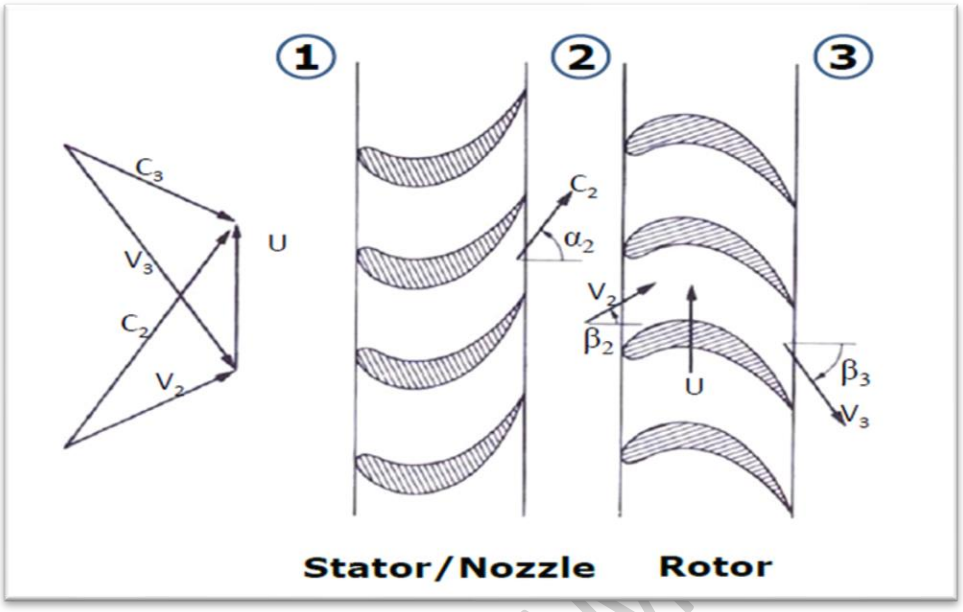



## UNIT - IV

5. a) Explain the different turbine blade cooling methods with neat sketch. **10**

   b) Combustion gases enter the first stage of a gas turbine at a stagnation temperature and pressure of 1200 K and 4.0 bar. The rotor blade tip diameter is 0.75m, the blade height is 0.12m and the shaft speed is 10,500 rpm. At the mean radius the stage operates with a reaction of 50%, a flow coefficient of 0.7and a stage loading coefficient of 2.5. Determine (a) the relative and absolute flow angles for the stage; (b) the velocity at nozzle exit; (c) the **10**

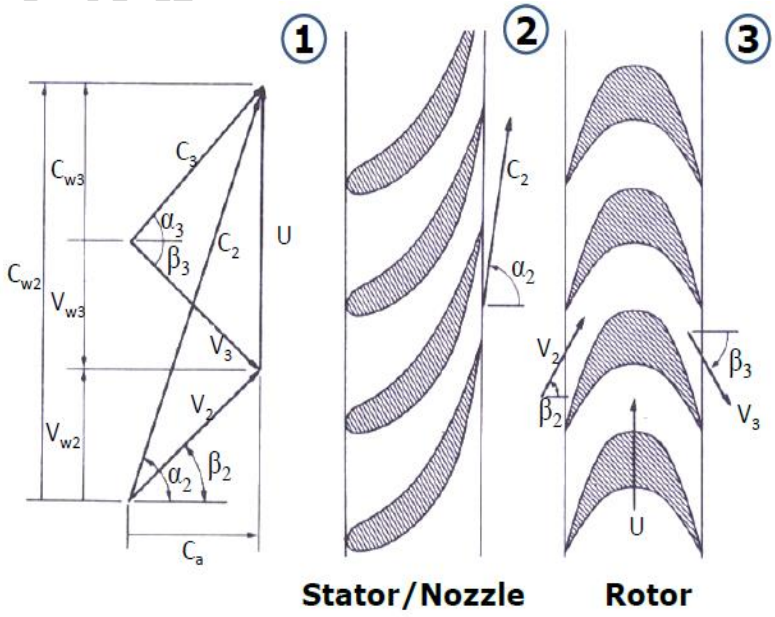
static temperature and pressure at nozzle exit assuming a nozzle efficiency of 0.96 and the mass flow.




**OR**

6. a) Discuss about the turbine and compressor matching. **10**

b) A multi-stage axial turbine is to be designed with impulse stages and is to operate with an inlet pressure and temperature of 6 bar and 900 K and outlet pressure of 1 bar. The isentropic efficiency of the turbine is 85 %. All the stages are to have a nozzle outlet angle of 75° and equal inlet and outlet rotor blade angles. Mean blade speed is 250 m/s and the axial velocity is 150 m/s and is a constant across the turbine. Estimate the number for stages required for this turbine. **10**



## UNIT - V

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| 7. | a) | With a neat sketch, explain the essential parts of a centrifugal compressor. | **06** |
| | b) | Discuss the performance characteristics of centrifugal compressor. | **06** |
| | c) | A centrifugal compressor under test gave the following data. Speed =11,500rev/min, inlet total head temperature=21°C, outlet and inlet total head pressure =4 bar, 1bar, impeller dia = 75cm. If the slip factor is 0.92, what is the compressor efficiency? | **08** |

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