Name:

Enrolment No:

UPES

End Semester Examination, May 2024

Course: Propulsion-I **Semester :IV**

Program: B. Tech Aerospace **Time : 03 hrs.**

Course Code: ASEG2007 **Max. Marks : 100**

Instructions:

1. **The Question paper has three sections: Section A, B and C.**
2. **Section B and C have internal choices**
3. **Assume the suitable data if needed**

SECTION A
(5Qx4M=20Marks)

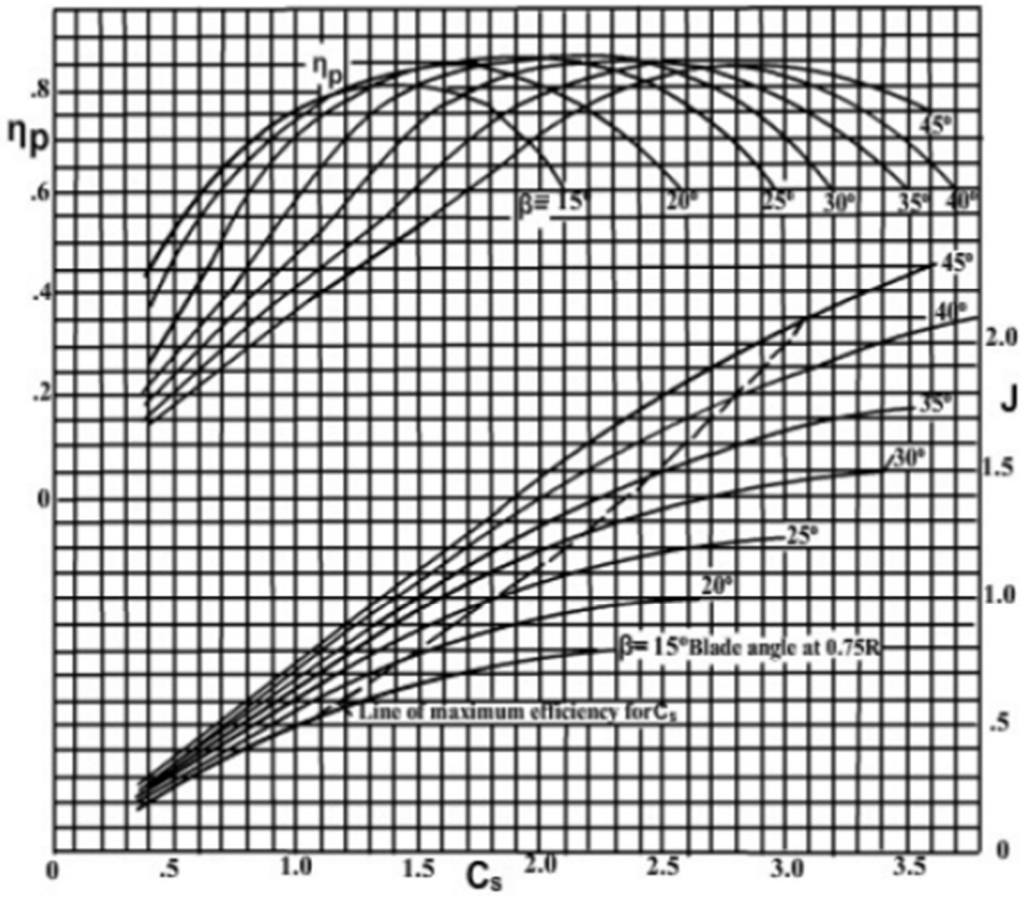
S. No.		Marks	CO
Q 1	Discuss the advantages of centrifugal compressor over the axial flow compressor.	**04**	**CO1**
2	Describe the advantages of closed circuit gas turbine plant over an open circuit tye?. Give three practical example where closed circuit gas turbine plants are used.	**04**	**C01**
3	Explain the different losses in axial flow compressor.	**04**	**C01**
4	Compare the fixed and variable pitch propeller with their	**04**	**C02**
5	Discuss the material and aerodynamic problem arise by the use of high temperature gas in turbine stages?. How are they overcome.	**04**	**C02**

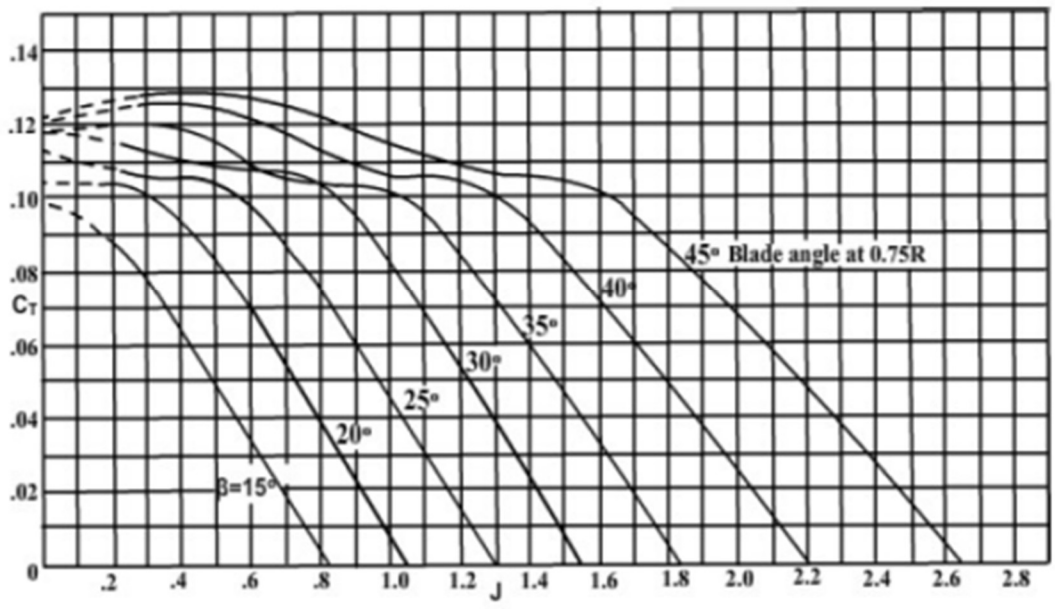
SECTION B
(4Qx10M= 40 Marks)

6	A single-stage centrifugal compressor receives air at a stagnation pressure of 1.013 bar and a stagnation temperature of 288 K. The rotor tip speed is 450 m/s and the velocity at the impeller eye is 100 m/s. The inlet (eye) hub and shroud diameters are 6 cm and 12 cm, respectively. The isentropic efficiency of the compressor is 0.85. Determine the vane angle, β1 2 if the slip factor is 0.95. If the compressor is fitted with inlet guide vanes, calculate the prewhirl angle required to obtain a stagnation pressure ratio across the compressor of 4.0. The rotational speed is 36,000 rpm. Assume that the slip factor is 0.95.	**10**	**CO4**
7	An aerospace company is designing a new jet engine for a supersonic aircraft. They are considering a gas turbine cycle with reheat to achieve maximum efficiency and thrust. The engine operates at an inlet temperature of 300 K and a pressure of 1 atm. The following data is provided for the engine: Isentropic efficiency of the compressor: 85%	**10**	**C02**

	Isentropic efficiency of the turbine: 90% Maximum temperature in the cycle after the first stage of compression: 1000 K Maximum temperature in the cycle after the reheat: 1400 K Maximum pressure in the cycle after the first stage of compression: 5 atm Maximum pressure in the cycle after the reheat: 15 atm The company needs to analyze the efficiency and performance of this gas turbine cycle with reheat.		
8	The velocities far upstream and downstream of an open propeller fan (d= 50 cm) are 5 and 25 m/s, respectively. If the ambient conditions are p= 1.02 bar, T= 37^0C. determine a) Flow rate through the fan b) Total pressure developed by the fan and c) The power required to drive the fan assuming the overall efficiency of the fan as 40 % . **OR** An aircraft while cruising at 700 km/hr is expected to encounter 6000 N of drag. The propeller flying this aircraft is of diameter 3.657 m and is designed with NACA 5868-9 3-bladed propeller blades. The engine delivers 1500.4 kW while the propeller runs at 1350 rpm. Check if the aircraft propeller matching for cruise flight is achieved. Compute any extra power or power shortfall that may be found.	**10**	**C03**
9	Discuss the different types of losses associated with axal flow compressor.	**10**	**C02**
	SECTION-C **(2Qx20M=40 Marks)**		
10	An axial compressor stage has the following data: Degree of reaction : 50%, Mean blade dia: 36cm, rotational speed: 18000 rpm, blade height at entry: 6 cm, air angles at rotor inlet and stator exit: 25^0 , axial velocity: 180 m/s, workdone factor: 0.88, stage efficiency: 0.85, mechanical efficiency: 96.7%. Determine (a) air angles at rotor and stator entry (b) mass flow rate (c) power required (d) stage loading coefficient (e) pressure ratio developed by stage (f) relative Mach number at rotor entry.	**20**	**CO3**
11	A single stage axial flow turbine operates with an inlet temperature of 1100 K and total pressure of 3.4 bar. The total temperature drop across the stage is 144 K and the isentropic efficiency of the turbine is 0.9. The mean blade speed is 298 m/s and the flow coefficient is 0.95. The turbine operates with a rotational speed of 12000 rpm. If the convergent nozzle is operating under choked condition determine. (a) blade loading coefficient	**20**	**C04**

	(b) pressure ratio of the stage and (c) flow angles. **OR** A single stage axial turbine has a mean radius of 30 cm and a blade height at the stator inlet of 6 cm. The gases enter the turbine stage at 1900 kPa and 1200 K and the absolute velocity leaving the stator is 600 m/s and inclined at an angle of 65 deg to the axial direction. The relative angles at the inlet and outlet of the rotor are 25 deg and 60 deg respectively. If the stage efficiency is 0.88, calculate (a) the rotor rotational speed (b) stage pressure ratio (c) flow coefficient (d) degree of reaction and (e) the power delivered by the turbine.		

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.12
.10
.08
C_T
.06
.04
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0
.2
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.6
.8
1.0
1.2
J
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
45° Blade angle at 0.75R
40°
35°
30°
25°
20°
β=15°