Name: **Enrolment No:**	UPES University of Tomorrow

UPES

End Semester Examination, May 2025

Course: Semester:IV

Program: B.Tech ASE — **Time : 03 hrs.**

Course Code: ASEG-2002 — **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)

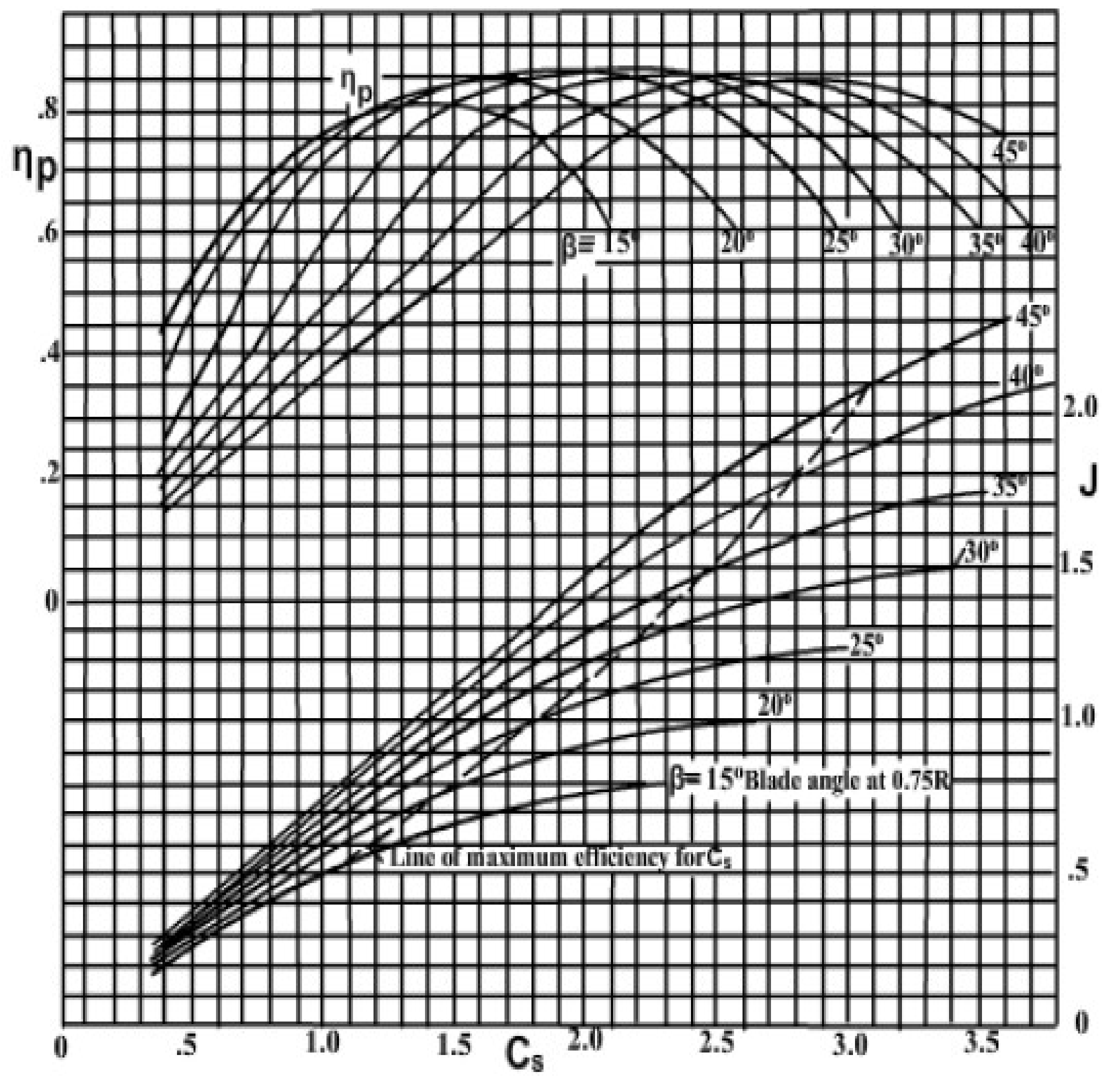
S. No.		Marks	CO
Q 1	Discuss the blade cooling technology development over the years, along with the turbine inlet temperature.	**4**	**CO1**
2	Draw the performance map of an axial flow compressor and discuss the salient points.	**4**	**CO4**
3	Explain the 2D losses associated with the axial flow turbine.	**4**	**CO2**
4	Show the variation of blade setting angle in a propeller blade from root to tip	**4**	**CO2**
5	Discuss the advantages of the Gas Turbine over the reciprocating engine.	**4**	**CO1**

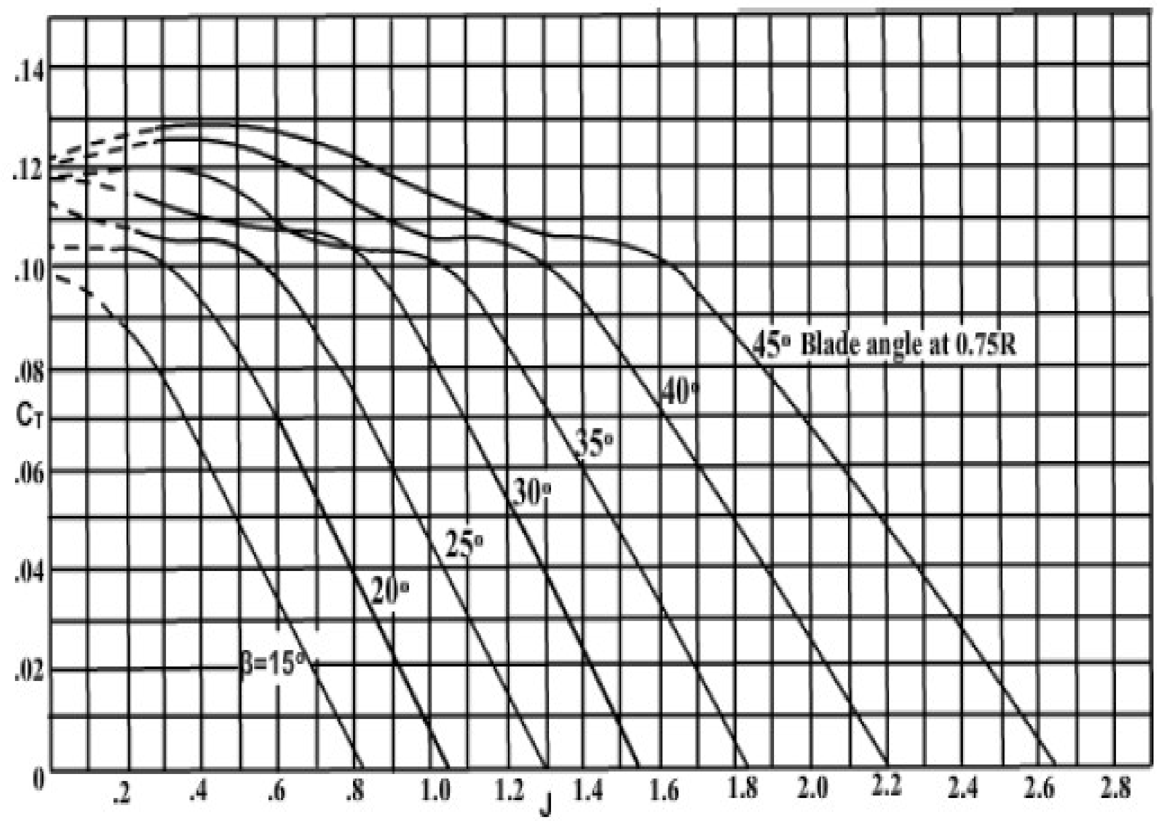
SECTION B
(4Qx10M= 40 Marks)

6	Determine the thermal efficiency and specific work output of gas turbine plant where air at 10^0C and 1 bar is compressed to 4 bar with compressor efficiency of 100%. The air is heated in the regenerator having 100 per cent effectiveness and the combustion chamber till its temperature is raised to 700◦C and has a pressure drop of 0.14 bar.	**10**	**CO3**
7	Derive the expressions for total thrust and torque produced by a propeller blade using the principles of Blade Element Theory.	**10**	**CO2**
8	Determine the approximate pressure ratio expected if the centrifugal compressor operates at an altitude of 5,500 m, where the ambient total pressure is 40 cm of Hg and the ambient total temperature is 255 K. Calculate the actual delivery temperature and the power required to compress air at a mass flow rate of 0.6 kg/s. if the impeller diameter of 45 cm operates at a speed of 16,000 rpm and delivers air with an isentropic efficiency of 0.80	**10**	**C03**
9	A turboprop engine drives a NACA 16-418 series propeller with a diameter of 3.5 meters. The propeller speed is maintained at 1100 rpm through a constant	**10**	**C04**

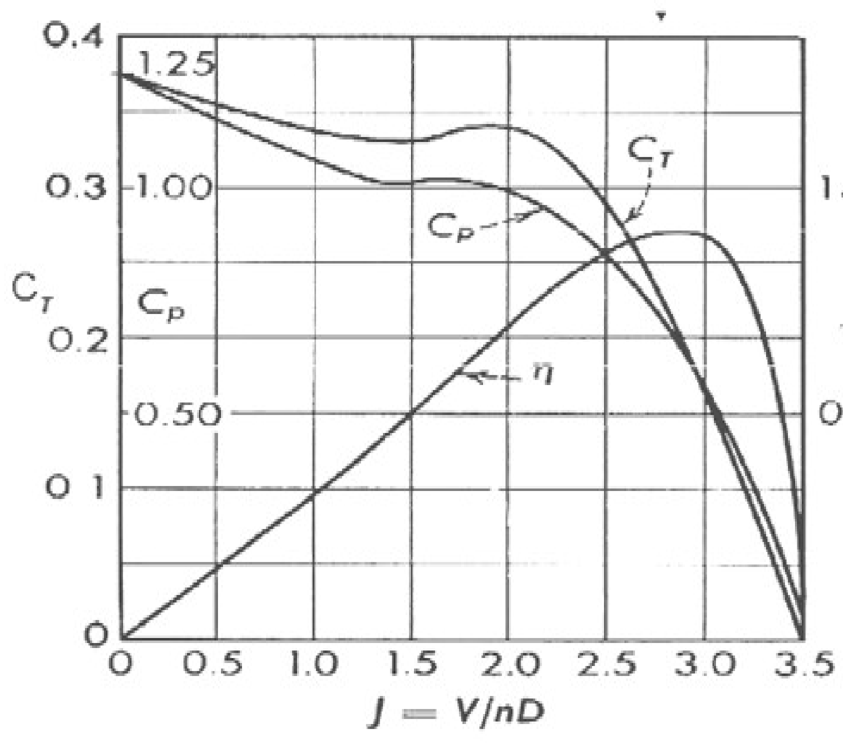
	speed unit. The engine delivers 950 kW. Draw graphs of THP vs. flight speed for flight speeds of 90, 180, 270, 360, and 450 km/hr. Show on the same plot the efficiency and blade angle variation with speed. Assume standard atmospheric conditions and that the performance data for NACA 16-418 are available. OR A turboprop aircraft is designed for maximum propeller efficiency at a cruising speed of 180 m/s. The engine, connected to a 1:4 gearbox, spins the propeller at 2500 rpm and provides 1200 kW of power at this optimal condition. Using the concept of speed-power characteristics: a) Estimate the optimal propeller diameter for this flight condition. b) What is the expected maximum efficiency of the propeller at this design point? c) If the aircraft's speed increases to 220 m/s while maintaining the same propeller RPM, determine the new advance ratio and the approximate corresponding efficiency.		
SECTION-C **(2Qx20M=40 Marks)**			
10	Air is compressed in a multistage axial compressor with symmetrical blades. The mass flow rate is 12 kg/s, and the desired pressure ratio is 5.2. The inlet velocity is 210 m/s, and the flow makes an angle of 13° with the axial direction. The mean blade speed is 260 m/s, and rotor speed is 5200 rpm. Calculate: A. The inlet and outlet blade angles B. The number of stages required C. The blade height at mean radius Assume stage efficiency = 0.91, inlet total temperature = 305 K, and pressure = 1 bar.	**20**	**CO3**
11	A single-stage axial turbine has a mean radius of 0.32 m and a constant blade height of 7.5 cm. The gas enters the stator at 1950 kPa and 1180 K. The absolute velocity leaving the stator has an axial component of 380 m/s and a tangential component of 750 m/s. The rotor inlet relative angle is 32 degrees, and the stage total-to-total pressure ratio is 3.0. If the stage efficiency is 0.89, determine: (a) the rotor rotational speed, (b) the rotor outlet relative angle, (c) the absolute velocity leaving the rotor, (d) the degree of reaction, and (e) the power delivered by the turbine. **OR** Based on the given operating parameters, design an axial flow turbine to drive the compressor in a pure turbojet engine. Assume any additional standard design parameters where necessary and provide appropriate justification for the assumptions made. Given Data: 1. Net work required by the compressor = 40 kW 2. Maximum combustion temperature = 1300 K 3. Ambient pressure = 1 atm 4. Maximum turbine rotational speed = 20,000 rpm 5. Maximum mass flow rate of air = 50 kg/s (Neglect fuel mass flow rate)	**20**	**CO4**

	a. Perform a complete design of the axial flow turbine. b. Use a block diagram to illustrate the step-by-step design procedure clearly. c. Justify each step, especially assumptions regarding efficiencies, temperature drops, blade angles, reaction ratio, and flow conditions. d. Ensure that the turbine provides sufficient power to drive the compressor, maintaining energy balance in the cycle.		





.14
.12
.10
.08
C_T
.06
.04
.02
0
.2 .4 .6 .8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8
J
45° Blade angle at 0.75R
40°
35°
30°
25°
20°
β=15°



0.4
1.25
0.3
1.00
C_T
C_P
0.2
0.50
0 1
0
1.0
0.5
η
C_T
C_P
η
0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
$J = V/nD$