Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2022

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

Program: B. Tech ASE & B. Tech ASE+AVE **Time : 03 hrs.**

Course Code: ASEG 2007 **Max. Marks: 100**

Instructions: Make use of *sketches/plots* to elaborate your answer. Brief and to the point, answers are expected. *Assume suitable data if needed*

S. No.		Marks	CO
	SECTION A **(5Qx4M=20Marks)**		
Q 1	Discuss the simple Brayton cycle with neat sketch.	**04**	**CO1**
Q 2	Compare the Otto, diesel and dual cycle best on performance parameters.	**04**	**CO2**
Q 3	Discuss the effect of slip phenomenon in centrifugal compressor through velocity tringle.	**04**	**CO1**
Q 4	Explain the loss associated in Axial turbine during functionality.	**04**	**CO1**
Q 5	Draw the performance curve of an Axial compressor and discuss the salient points.	**04**	**CO2**
	SECTION B **(4Qx10M= 40 Marks)**		
Q 6	Derive the equation for Impulse effect, centrifugal effect and diffusion effect in a centrifugal compressor through velocity tringle and discuss their effect on the rotor and stator performance.	**10**	**CO2**
Q 7	Analyze a Gas Turbine Plant working on the Brayton cycle with a regenerator of 75% effectiveness, the air at the inlet to the compressor is at 0.1 MPa, 30^0 C, the pressure ratio is 6 and the maximum cycle temperature is 900^0 C. if the turbine and compressor have each an efficiency of 80% find the percentage increase in the cycle efficiency due to regeneration.	**10**	**C03**
Q 8	Derive the Actuator disc theory for Propeller blade and discuss the assumption taken for the derivation.	**10**	**C03**
Q 9	Analyze the performance of compressor where Each stage of an axial flow compressor is of 0.5 reaction, has the same mean blade speed and the same flow outlet angle of 30^0deg relative to the blades. The mean flow coefficient is constant for all stages at 0.5. At entry to the first stage the stagnation temperature is 278 K, the stagnation pressure 101.3 kPa, the static pressure is 87.3 kPa and	**10**	**C04**

	the flow area 0.372 m^2. Using compressible flow analysis determine the axial velocity and the mass flow rate. Determine also the shaft power needed to drive the compressor when there are six stages and the mechanical efficiency is 0.99. **OR** 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, work done 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.		
SECTION-C (2Qx20M=40 Marks)			
Q 10	Analyze 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. **OR** Design of an axial-flow gas turbine stage with stagnation conditions at stage entry of P01 = 400kPa, T01 = 850K, is to be based upon the following data applicable to the mean radius: Flow angle at nozzle exit, = 63.8 deg Reaction, R = 0.5 Flow coefficient, cx /Um = 0.6 Static pressure at stage exit, P3 = 200kPa Estimated total-to-static efficiency, = 0.85. Assuming that the axial velocity is unchanged across the stage, determine (i) the specific work done by the gas; (ii) the blade speed; (iii) the static temperature at stage exit. (iv) the rotor speed (rev/min); (v) the mean diameter; (vi) the hub–tip radius ratio.	**20**	**CO4**

Q 11	**A)** Estimate the power available for the airscrew in a turboprop engine if the axial compressor of a gas turbine delivers 20 kg/s of air at a pressure ratio of 5 with an isentropic efficiency of 80% inlet temperature and pressure are 22^0C and 1 bar. Calculate the power required by the compressor. After heating at constant pressure to 870^0C the gas is expanded to 1 bar through a turbine with efficiency of 85 %. The turbine is direct coupled to the compressor and to an airscrew reduction gear which has an efficiency of 95% **[10]** B) Following are the Given data for XYZ Aircraft Thrust required = 100 KN Operating Mach number= 0.7 Type of Engine = Simple Bryton cycle No. of stages in compressor = Based on designer optimization Efficiency of Compressor = 0.85 Maximum Operating temperature = 2000K Total pressure ratio required = 10 Each stage pressure rise limited to 1.4 Engine running speed = 30000 Rpm **[10]** Based on the above data write down the complete step for designing an engine, justify your each selection of the component inside the engine.	**20**	**C03**