U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

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

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

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	*CO*	*PO*	Marks
1	a)	A simple turbojet unit operates with a maximum turbine inlet temperature of 1200K, pressure ratio of 4.25:1 and a mass flow rate of 25kg/s under design conditions, the following component efficiencies may be assumed Isentropic efficiency of the compressor: 87% Isentropic efficiency of the Turbine: 91.5% Propelling nozzle efficiency: 96.5% Transmission efficiency: 98.5% Combustion chamber Pressure loss: 0.21bar Calculate the total design thrust.	*CO 1*	*PO 2*	**10**
	b)	Highlight the significant features of a turboprop engine. With a neat diagram, explain its working characteristics.	*CO 2*	*PO 2*	**10**
		OR			
2	a	A turbojet is flying at a speed of 720 km/h in a surrounding atmosphere of 0.6 bar and 260 K. The air enters the diffuser first and then enters into the compressor. The pressure ratio of the compressor is 4.5. The maximum temperature entering into the turbine is limited to 977°C. The hot gases coming out of the turbine expands in the nozzle to pressure of 0.7 bar. Take the following data. Diffuser efficiency of 95%, C.V of fuel used = 40000 kJ/kg, air used = 1200 kg/min. Neglect the velocity of the air leaving the diffuser. Determine i) Power consumed by the compressor ii) A: F ratio used iii) thrust power of the engine. Take $C_{pa} = C_{pg} = 1.0$, $\gamma_a = \gamma_g = 1.4$; $\eta_d = 95\%$, $\eta_c = 82\%$, $\eta_t = 85\%$, $\eta_n = 94\%$.	*CO 2*	*PO 2*	**10**
	b	Illustrate a Turbojet engine with a neat sketch and explain its principle of operation. Draw the TS diagram for ideal turbojet and afterburner.	*CO 2*	*PO 2*	**10**

			UNIT - II			
	3	a)	Identifying the various zones in a combustion chamber, explain its functioning with a neat sketch.	*CO 3*	*PO 2*	**10**
		b)	Illustrating with a neat sketch, describe the working of a convergent nozzle showing the variation of mass flow rate and pressure through the Convergent nozzle.	*CO 2*	*PO 2*	**10**
			OR			
	4	a)	With the help of TS diagram explain the intake operation for takeoff and cruise level condition.	*CO3*	*PO2*	**10**
		b)	Explain the types of compression in supersonic intake. Use necessary sketches.	*CO2*	*PO2*	**10**
			UNIT - III			
	5	a)	Explain the flow through a single stage axial flow compressor and decompose the fluid velocity components at the inlet and outlet of the blade manifested on a neat sketch.	*CO 3*	*PO 2*	**10**
		b)	Write a brief note on degree of reaction for axial flow compressors.	*CO 3*	*PO 2*	**10**
			OR			
	6	a)	Derive an expression for work input for an axial flow compressor.	*CO 3*	*PO 2*	**10**
		b)	Air at 1.0132 bar and 288K enters an axial compressor stage with an axial velocity 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 30.2^0 as it passes through rotor. Assume a stage pressure ratio of 1.2. Assuming the constant specific heats and that the air enters and leaves the blade at the blade angles, i) construct the velocity diagram at mean dia for this stage ii) mass flow rate iii) power required iv) degree of reaction	*CO 3*	*PO 2*	**10**
			UNIT - IV			
	7	a)	With the help of TS diagram explain the operation of an axial flow turbine stage.	*CO 4*	*PO 2*	**10**
		b)	A multistage gas turbine is to be designed with impulse stages and is to operate with an inlet pressure and temperature of 6 bar and 900K and an outlet pressure of 1 bar. The isentropic efficiency of the turbine is 85%. All the stages are to have a nozzle outlet angle of 75^0 and equal outlet and inlet blade angles. Mean blade speed	*CO 4*	*PO 2*	**10**

			of 250 m/s and equal inlet and outlet gas velocities. Estimate the maximum number of stages required.			
			OR			
	8	a)	Interpret the steps involved in Compressor and Turbine matching.	*CO4*	*PO2*	**10**
		b)	What are the various blade cooling techniques in axial turbine? Use necessary sketches.	*CO4*	*PO2*	**10**
			UNIT - V			
	9	a)	Bring out the technical differences between centrifugal and axial flow compressors. Additionally, describe the functioning of the centrifugal flow compressor highlighting all the important components with a neat sketch.	*CO 3*	*PO 2*	**06**
		b)	What are the various losses in a centrifugal compressor? Also write the graphical representation.	*CO 2*	*PO 2*	**04**
		c)	A centrifugal compressor has a pressure ratio of 4:1 with an isentropic efficiency of 80% when running at 15000 rpm and inducing air at 293K. Curved vanes at inlet give the air a prewhirl of 25^0 to the axial direction at all radii and the mean dia of eye is 250 mm. The absolute air velocity at inlet is 150m/s. Impeller tip dia is 600mm. Calculate the slip factor.	*CO 3*	*PO 2*	**10**
			OR			
	10	a)	Derive an expression for work done per unit mass in terms of pressure ratio.	*CO3*	*PO2*	**10**
		b)	A centrifugal compressor runs at 15000 rpm and produces a stagnation pressure ratio of 4 between the impeller inlet and outlet. Stagnation conditions of air at the intake are 100 kPa and 300 K. The absolute velocity at the compressor intake is without any whirl component. At the exit of the impeller, the flow component of the velocity is 135 m/s and the blades are radial. The total-to-total efficiency of the compressor is 0.78. Draw the velocity triangles and find the blade angle at the inlet. Also compute the slip and slip coefficient. The rotor diameter at the exit is 0.58 m and that at the inlet is 0.25m.	*CO3*	*PO2*	**10**

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