Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Course: Propulsion-II **Semester: VI**
Program: B.TECH ASE, ASE+AVE **Time 03 hrs.**
Course Code: ASEG 322 **Max. Marks: 100**

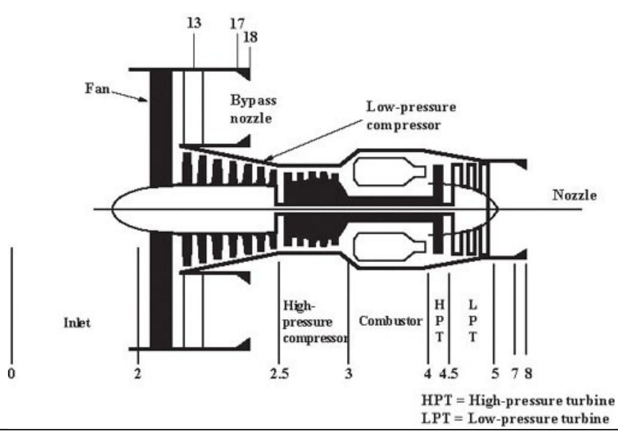
Instructions:
Isentropic Tables, Shock Tables, Standard Atmospheric Tables, Relay Flows, Fanno Flow Tables are allowed

SECTION A (20 Marks)

S. No.		**Marks**	**CO**
Q 1	Discuss the effect of friction on compressible flow though a constant area duct and explain the phenomena of chocking	**5**	**CO1**
Q 2	Compare the turbojet engine and ramjet engine and bring out the advantages and limitations of both the engines?	**5**	**CO4**
Q 3	Explain the through filed flow in axil flow compressors using velocity triangles and express all the component velocities for a stator and rotor stages?	**5**	**CO5**
Q 4	Explain the concept of Thrust vectoring used in nozzles and what are the effects of shock waves in the Convergent-Divergent Nozzles?	**5**	**CO3**

SECTION B (40 Marks)

Q 5	A perfectly Designed convergent divergent diffuser is directly fitted to the exit of a duct of uniform cross-section 0.001 m^2. The air at the exit of the duct is at 0.105 MPa and 75^0 C, is having a velocity of 600 m/s. Estimate the pressure of air at the exit of the diffuser, if the area of the diffuser at exit is same as the area at inlet. Also, find the throat area and the mass flow rate. Assuming Isentropic flow.	**10**	**CO2**
Q 6	Explain about Main Burner types, and Burner components for air breathing Engines, airflow distribution and cooling air. What is the significance of Equalence Ration and Explain the Theoretical air requirement calculation Procedure?	**10**	**CO1**
Q 7	A turbojet engine flying at a speed of 900 km/h is fitted with a convergent divergent nozzle having an exit diameter 500 mm and area ratio 2. The exit from the turbine of the engine is 300 kPa and 500 K. Find the thrust developed by the engine if the atmospheric pressure at altitude is 20 kPa. Assume properties of the exhaust gas to be same as that of air. Fuel air ratio for the engine is 0.02167.	**10**	**CO3**
Q 8	A combustion chamber in a gas turbine plant receives air at 300 K, 55 kPa and 60 m/s. The fuel air ratio is 29 and the calorific value of the fuel is 42 MJ/kg. Assuming Υ=1.4 and R=0.287 kJ/kg K for the gas determine (i). Mach number at inlet and exit	**10**	**CO2**

<table>
<tr><td></td><td>(ii) Pressure, temperature and velocity of the gas at exit of combustion chamber
(iii). Percentage loss in stagnation pressure
(iv). Maximum attainable stagnation temperature</td><td></td><td></td></tr>
<tr><td></td><td>(OR)
Air enters a circular duct of 15 cm diameter with a Mach number 0.5, pressure 300 kN/m^2 and temperature 320 K. Average Friction factor for duct is 0.005. Assuming chocked adiabatic flow with friction, determine
(i). length of duct
(ii). change in entropy
(iii). Change in impulse function
(iv). Loss in isentropic stagnation pressure</td><td></td><td></td></tr>
<tr><td colspan="4">SECTION-C (40 Marks)</td></tr>
<tr><td>Q 9</td><td>Air at 1.0132 bar and 288 K enters an axial flow compressor stages 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 diameter fir this stage
(ii). Mass flow rate
(iii). Power required
(iv). Degree of Reaction</td><td>20</td><td>CO5</td></tr>
<tr><td>Q 10</td><td>Explain the method of Real cycle analysis using the T-S Diagram for Turbofan engine. Derive the expressions for specific thrust, specific fuel consumption, exit Mach numbers, Velocity ratio, thermal efficiency, Propulsive efficiency and Overall Efficiency

</td><td>20</td><td>CO4</td></tr>
<tr><td></td><td>(OR)
Consider a turbo jet engine with losses, calculate the performance of a turbofan engines, Specific Thrust, Specific Fuel Consumption, Exit Velocity Ratio, Thermal Efficiency, Propulsive Efficiency using real cycle analysis for the following data</td><td></td><td></td></tr>
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<table>
<tr>
<td></td>
<td>M_0=2, T_0=216.7 K, Υ_c=1.4, c_{pc}=1.004 kJ/kg.K, Υ_t=1.3, c_{pt}=1.239 kJ/kg.K, h_{pr}=42,800 kJ/kg, π_b=0.94, π_{dmax}=0.95, π_n=0.96, e_c=0.9, e_t=0.9, η_b=0.98, η_m=0.99, P_0/P_9=0.5, T_{t4}=1800 K, π_c=10.

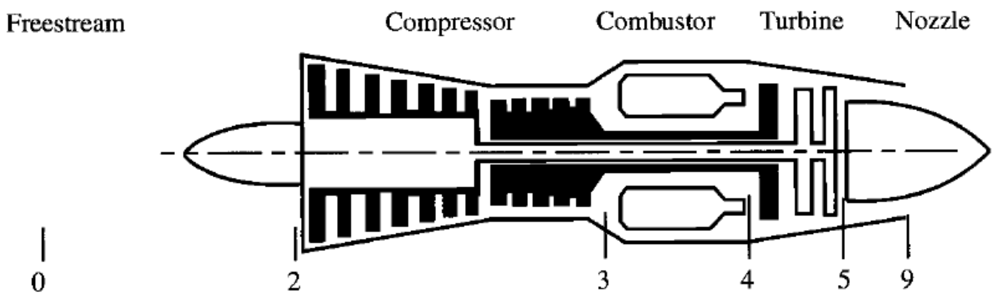

Fig. 7.1 Station numbering of turbojet engine.</td>
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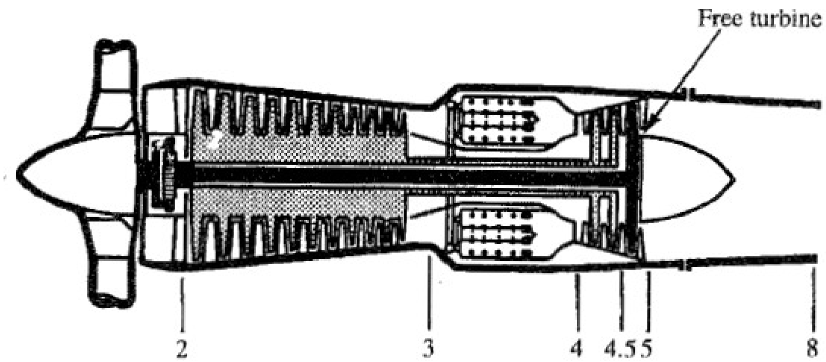
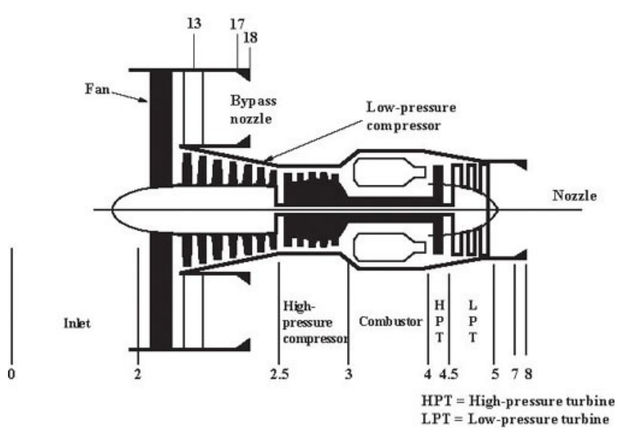
SECTION A (20 Marks)

S. No.		Marks	CO
Q 1	Explain the significance of Maximum entropy condition for the flow of a perfect gas in a constant area duct and explain the different terms	**5**	**CO1**
Q 2	What is the difference between air specific impulse and fuel specific impulse? How these two parameters are useful in comparing different propulsion system?	**5**	**CO4**
Q 3	Explain the through filed flow in axil flow turbine using velocity triangles and express all the component velocities?	**5**	**CO5**
Q 4	Illustrate the working principle of ramjets, and supersonic inlets. Explain the effect of shockwaves at the inlet of the diffuser?	**5**	**CO3**

SECTION B (40 Marks)

Q 5	Air flows through a convergent nozzle and exhaust to atmosphere where the pressure is 1.014 bar. The reservoir from which air is flowing is at a pressure of 6.895 bar. And 200.9K. Calculate (i). the pressure in the nozzle exit plane (ii). the minimum pressure in the reservoir for which the flow is chocked?	**10**	**CO2**
Q 6	Explain about Nacelle and Interference Drag and types of flow configurations in the diffusers?	**10**	**CO2**
Q 7	A turbojet engine has a flight velocity of 900 km/h at an ambient of 60 kPa. The total properties of the gas entering the nozzle are 300 kPa and 300^{0}C. The mass flow rate of air is 20 kg/s. The air fuel ratio is 80. There is complete expansion in the nozzle. Assuming ideal expansion and the properties of the combustion gases to be the same as that of air, Calculate (i). Throat and exit area of the nozzle (ii). exit velocity and Mach number (iii). Thrust and thrust power (iv). Propulsive power and propulsive efficiency.	**10**	**CO3**
Q 8	What is meant by Thrust? Derive the thrust Equation for a general propulsion system? (OR) Explain the Principle of afterburner and explain the various performance parameters for afterburners. How it is useful in Thrust augmentation?	**10**	**CO1**

SECTION-C (40 Marks)			
Q 9	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 900 K 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 of 250 m/s and equal inlet and outlet gas velocities. Estimate the maximum number of stages required. Assume C_p=1.15 kJ/kg K, Υ=1.333 and optimum blade speed ratio.	**20**	**CO5**
Q 10	Explain the method of Real cycle analysis using the T-S Diagram for Turboprop engine. Derive the expressions for specific thrust, specific fuel consumption, exit Mach numbers, Velocity ratio, thermal efficiency, Propulsive efficiency and Overall Efficiency  (OR) Consider a turbofan engine with losses, calculate the performance of a turbofan engines, Specific Thrust, Specific Fuel Consumption, Exit Velocity Ratio, Thermal Efficiency, Propulsive Efficiency using real cycle analysis for the following data M_0=0.8, T_0= 390^0R, γ_c=1.4,c_{pc}=0.240 Btu/(lbm.^{0}R), h_{PR}=18,400, γ_c=1.4,c_{pc}=0.240 Btu/(lbm.^{0}R), γ_t=1.4,c_{pt}=0.276 Btu/(lbm.^{0}R), $\pi_{d\ max}$= 0.99, π_b=0.96, π_n=0.99, π_{fn}=0.99, e_c=0.90, e_f=0.89, e_t=0.89, η_b=0.99, η_m=0.99, P_0/P_9=0.9, P_0/P_{19}=0.9, T_{t4}=3000 ^{0}R, π_C=0.96, π_f=1.7, α=8. 	**20**	**CO4**