IV SEMESTER B.TECH (AERONAUTICAL/AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2016

SUBJECT: AIRCRAFT PROPULSION [AAE 2202]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Give the various classifications of aero engines. **(02)**

1B. Air enters an aircraft at a velocity of 180 m/s with a flow rate of 94 kg/s. the engine combustor requires 9.2 kg/s of air to burn 1 kg/s of fuel. The velocity of gas exiting from the engine is 640 m/s. Find the momentum thrust developed by the engine (in N). **(02)**

1C. Describe the following terms: **(06)**

i. Propulsive efficiency
ii. Ram compression
iii. Propfan
iv. Nozzle Choking
v. By-pass ratio
vi. Gas generator

2A. How is high thrust requirement met in piston prop engines flying at high altitudes? **(02)**

2B. Derive the expression for polytropic efficiency in a compressor. **(04)**

2C. The polytropic efficiency of compressor is 85% and turbine is 90%. If the ideal outlet temperature of compressor is twice that of the inlet, calculate their isentropic efficiencies, assuming that there is no pressure loss. Take γ_a = 1.4 and γ_g= 1.33. **(04)**

3A. What peculiarities make the Pratt and Whitney JT-8D engine suitable for using in commercial aircrafts? Explain. **(02)**

3B. Sketch an afterburning turbojet engine with appropriate station numbers and draw the T-S diagram for its Ideal cycle operation. **(02)**

3C. The following data apply to a turbojet aircraft flying at a speed of 805 km/h, at an ambient temperature of 248 K and pressure of 0.458 bar. Find Thrust and TSFC. **(06)**

Compressor exit pressure	2.52 bar
Pressure loss in combustion chamber	0.21 bar
TIT	1100 K
Fuel- air ratio	0.022
Turbine exit total temperature	965 K
Isentropic efficiency of turbine	0.9
Nozzle efficiency	0.95
Nozzle exit area	0.0935 m^2

Take Cp_a = 1.005 kJ/kgK, γ_a = 1.4, Cp_g = 1.147 kJ/kgK, γ_g= 1.33.

4A. Compare axial and centrifugal compressor with the help of neat sketches. **(02)**

4B. An axial flow air compressor of 50% reaction design has blades with inlet and outlet angles of 40° and 12° respectively. The compressor is to produce a pressure ratio of 6:1 with an overall isentropic efficiency of 0.9 when the inlet static temperature is 40°C. The blade speed and axial velocity are constant throughout the compressor. Assuming the value of blade speed as 250 m/s, find the number of stages required if the work done factor is **(03)**
i) unity, ii) 0.88 for all stages

4C. Prove that, Degree of Reaction for an axial flow compressor stage **(05)**

$$R = \frac{1}{2} - \frac{1}{2} \cdot \frac{C_a}{U} (\tan \alpha_1 - \tan \beta_2)$$

Also sketch its velocity triangle for R= 0.5.

5A. Name the methods used in turbine blade cooling. **(02)**

5B. Give reason for the following **(03)**

I. Using shrouded rotor blades in axial flow turbines.
II. Use of fir tree arrangement to fix turbine blades to the hub.
III. The number of stages in axial turbines is less compared to compressors in a gas generator.

5C. A gas turbine engine operating at a pressure ratio of 11.314 produces zero net work output when 476.354 kJ of heat is added per kg of air mass. If the inlet air total temperature is 300 K and the turbine efficiency is 71%, find the compressor efficiency and temperature ratio (ratio of TIT to Inlet total temperature). Assume Cp = 1.005 kJ/kgK, γ = 1.4 for the whole cycle. **(05)**