Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

V SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: TURBOMACHINERY AERODYNAMICS [AAE 4017]

REVISED CREDIT SYSTEM
(03/12/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. A Brayton cycle operates with a regeneration of 88% effectiveness. The air at the inlet to the compressor is at 0.11 MPa and 36^0c, the pressure ratio is 6.5 and the maximum cycle temperature 950^0C. If the compressor and turbine have efficiencies of 95 percentage each, find the percentage increase in the cycle efficiency due to regeneration. **(5)**

1B. Draw the classification chart for basic jet engine types. **(3)**

1C. Write short note on thermodynamics of compressor. **(2)**

2A. Explain with notations the analysis of piston engine in terms of Power, indicated horse power (IHP), brake horse power (BHP), volumetric efficiency (η_{VOL}), propeller efficiency (η_P) and mechanical efficiency (η_m). **(5)**

2B. Derive the performance of turboprop engine. **(3)**

2C. Describe the aerodynamic coefficients of rotor blade. **(2)**

3A. Derive the equation for thermodynamic efficiency (η_{th}), turbine efficiency (η_{T}), compressor efficiency (η_{C}) of an ideal brayton cycle With P-V and T-S diagrams. **(5)**

3B. Define (i) flow coefficient (Φ) (ii) Stage loading (Ψ) (iii) Diffusion factor (D^*). **(3)**

3C. In one stage of an aircraft axial flow compressor, the pressure ratio is to be 1.22 and the air inlet stagnation is 288 K. If the stagnation temperature rise of stages is 21 k, the rotor tip speed is 200 m/sec, and the rotor rotates at 4500 rpm, calculate the stage efficiency and diameter of the rotor. **(2)**

4A. Draw the velocity triangle for axial and centrifugal compressors with all the symbols & notations, Also derive the equation for work done per unit mass of each compressor. **(5)**

4B. An axial flow compressor has an overall pressure ratio 4.5:1 and a mean blade speed of 245 m/sec. Each stage is of 50 % reaction and the relative air angles are the same 30^0 for each stage. The axial velocity is 158 m/sec and is constant through the stage. If the Polytropic efficiency is 87 % calculate the number stages required. Assume T_{01}=290 K. **(3)**

4C. Write down the various steps involved in design of compressor. **(2)**

5A. Air at 1.0 bar and 288K enters an aircraft axial flow compressor with an axial velocity of 150 m/sec. There are no inlet guide vanes. The rotor stage has a tip diameter of 60 cm and 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 degree as it passes through rotor. Assume a stage pressure of 1.2 bar and overall pressure ratio is 6. Determine: (i) Absolute velocity component at the exit of the rotor (ii) The mass flow rate of air (iii) The power required to drive the compressor (iv) The degree of reaction at the mean diameter (v) No. of compressor stages required if, the isentropic efficiency is 0.85 . **(5)**

5B. Explain with neat digrams losses in a compressor blade **(3)**

5C. Define the Propulsive efficiency (η_P) and specific fuel efficiency (SFC). **(2)**