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
(05/01/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. For an aircraft ideal IC engine operating with combustion at constant pressure given that it is operating with P_a=1 bar, T_a=350 K, compression Ratio 20, Isobaric expansion ratio 2. The working medium is air. For 1 Kg of air calculate (a) Workdone under various cycle legs, (b) Heat added and Heat rejected during various cycle legs, (c) Carnot cycle efficiency (d) Indicated mean effective pressure. Please note: Show all the stations parameters with neat PV-Diagram. **(5)**

1B. Explain clearly jet engine performance parameters with various plots. **(3)**

1C. Write the significance of “Degree of Reaction” in turbomachinery aerodynamics. **(2)**

2A. A centrifugal compressor has a pressure ratio of 4:1 with an isentropic efficiency of 80% when running at 16000 rpm and inducing air at 290 K. Curved vanes at the inlet give the air a pre whirl of 25^0c to the axial direction at all radii. The tip diameter of the eye of the impeller is 250 mm. the absolute velocity at inlet is 150 m/sec and impeller diameter is 600 mm. calculate the slip factor **(5)**

2B. List the advantages and dis advantages of centrifugal and axial compressors. **(3)**

2C. Define the stage efficiency of axial flow compressor. **(2)**

3A. An axial flow compressor has the following design data. Inlet stagnation temperature 290 K, Inlet stagnation pressure 1 bar, stage stagnation temperature rise 24 K, mass flow of air 22kg/sec, axial velocity through the stage 155.5 m/sec, rotational speed 152 revolutions per second, work done factor 0.93, mean blade speed 205 meters per second, reaction at the mean radius 50% . Determine (i) The blade and air angles at the mean radius (ii) The mean radius (iii) The blade height. **(5)**

3B. Discuss the analysis of centrifugal compressor. **(3)**

3C. Write short note on free vortex design in compressor blades. **(2)**

4A. A Brayton cycle operates with regenerator of 75 % effectiveness. The air at the inlet to the compressor is at 0.1 MPa and 30^0 C, the pressure ratio is 6 and maximum cycle temperature is 900^0 C. If the compressor and turbine have effectiveness of 80% each. Fine the percentage increase in the cycle efficiency due to regeneration. **(5)**

4B. Explain the thermodynamic analysis of turbine. **(3)**

4C. What is surging and chocking? **(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 graphs the performance of centrifugal compressor. **(3)**

5C. Write differences between Brayton cycle and Otto cycle. **(2)**