

MANIPAL INSTITUTE OF TECHNOLOGY MANIPAL

A Constituent Institution of Manipal University

## V SEMESTER B.TECH. (AERONAUTICAL ENGINEERING) END SEMESTER EXAMINATIONS, NOV/DEC 2018

## SUBJECT: TURBOMACHINERY AERODYNAMICS [AAE 4017]

## REVISED CREDIT SYSTEM (30/12/2018)

Time: 3 Hours

MAX. MARKS: 50

## Instructions to Candidates:

- ✤ Answer ALL the questions.
- Missing data may be suitable assumed.
- 1A. Discuss how turbomachinery components plays vital role in creating the thrust force in (2) aircraft engine?
- 1B. Write short note on advantages of Axial flow compressors over Centrifugal compressors. (3) Also draw the velocity triangle for Centrifugal compressor.
- 1C. A centrifugal compressor has a pressure ratio of 4:1 with an isentropic efficiency of 80% (5) when running at 15000 rpm and inducing air at 293 K. Curved vanes at the inlet give the air a pre whirl of 25°C 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.
- 2A. With the help of neat digrams explain aircraft various performance parameters with respect (4) to mass flow rate of air.
- 2B. An axial flow compressor has the following design data: Inlet stagnation temperature 290 K, (6) Inlet stagnation pressure 1 bar, stage stagnation temperature rise 24 K, mass flow of air 22 kg/sec, axial velocity through the stage 155.5 m/sec, rotational speed 152 rev/sec, workdone factor 0.93, mean blade speed 205 m/sec, reaction at the mean radius 50 %. Determine (i) The blade air angles at the mean radius (3M) (ii) The mean radius(1M) (iii) The blade height(2M).
- **3A.** Analyse the aircraft centrifugal compressor performance.

- (4)
- 3B. The following design data refers to a small turbojet centrifugal compressor air enters at a stagnation (6) temperature of 288 K and stagnation pressure ratio of 1.01 bar. The impeller has 17 radial vanes and no inlet guide vanes. The following design data apply: Mass flow rate 2.5 Kg/Sec, Impeller tip speed 475 m/sec, Mechanical efficiency 96%, Absolute air velocity at diffuser exit 90 m/sec, compressor isentropic efficiency 84 %. Absolute velocity at impeller inlet 150 m/sec, Diffuser efficiency 82%. Axial depth of impeller 6.5 mm, power input factor 1.04, Y for air 1.4.

Determine: (i) Shaft power(1M) (ii) Stagnation and static pressure at diffuser outlet (1M) (iii) Radial velocity, absolute Mach no, stagnation and static pressures at the impeller exit,

assume reaction-ratio as 0.5 (2M) and (iv) impeller efficiency and rotational speed (2M)

- **4A.** Explain the basic properties of aircraft fuels.
- **4B.** In a single stage axial flow gas turbine, gas enters the turbine at a stagnation temperature and **(4)** pressure of 1150 K and 8 bar respectively. Isentropic efficiency of the stage is equal to 0.88, mean blade speed is 300 m/sec, rotational speed 240 rps. The gas leaves the stage with velocity 390 m/sec. Assuming inlet and outlet velocities are same and axial find the blade height at the outlet conditions when the mass flow of gas is 34 kg/sec, temp drop in the stage is 145 K, take  $C_p = 1147 \text{ J/Kg.K}$  and  $\gamma_{eqs} = 1.333$ .
- **4C.** With the help of neat sketches show different types of fuel tanks used in aircraft systems. (2)
- **5A.** With the help of neat digrams explain the concept of fuselage mounted engines. (4)
- **5B.** In a centrifugal compressor air enters at a stagnation temperature of 288K and stagnation (6) pressure of 1.01 bar. The impeller has 17 radial vanes and no inlet guide vanes. The following data apply: Mass flow rate: 2.5kg/s, Impeller tip speed: 475m/s, Mechanical efficiency: 96%, Absolute air velocity at diffuser exit: 90m/s, Compressor isentropic efficiency: 84%, Absolute velocity at impeller inlet: 150m/s, Diffuser efficiency: 82%, Axial depth of impeller: 6.5mm, Power input factor: 1.04, Y for air: 1.4, Determine: (i) shaft power, (ii) stagnation and static pressure at diffuser outlet,(iii) radial velocity, absolute Mach number and stagnation and static, pressures at the impeller exit, assume reaction ratio as 0.5, and, (iv) impeller efficiency and rotational speed.

(4)