CBCS SCHEME

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15AE43

Fourth Semester B.E. Degree Examination, July/August 2022
Aircraft Propulsion

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. With a neat diagram, explain the working principle of four stoke spark ignition engine. **(06 Marks)**

b. State first and second law of thermodynamics. **(04 Marks)**

c. List out advantages and disadvantages of gas turbine engine over reciprocating engines. **(06 Marks)**

OR

2 a. Define : Specific heat of gases, Internal energy, enthalpy. **(08 Marks)**

b. Explain Brayton cycle with PV and TS diagram. **(06 Marks)**

c. Define Mach number. **(02 Marks)**

Module-2

3 a. With a neat sketch, explain working of turbo jet engine with its performance characteristics. **(08 Marks)**

b. In a turbojet unit with forward facing ram intake the jet velocity relative to the propelling nozzle at exit is twice the flight velocity. Determine the rate of fuel consumption in Kg/s, when developing a thrust of 25000N under the following conditions.

Ambient pressure and temperature	:	0.7 bar : 1°C
Compression total head pressure ratio	:	5:1
Flight Speed	:	800 Km/h
CV of fuel	:	42000 kJ/Kg
Ram efficiency	:	100%
Isentropic efficiency of compressor	:	85%
Isentropic efficiency of turbine	:	90%
Isentropic efficiency of nozzle	:	95%
Combustion efficiency	:	98%
Turbine pressure ratio	:	2.23

Assume the mass flow of fuel is small compared with the mass flow of air and that the working fluid throughout has the properties of air at low temperature. Neglect the extraneous pressure drop. Assume $C_{pg} = C_{pa} = 1.005$ kJ/Kg K. **(08 Marks)**

OR

4 a. Define : Thrust augmentation and explain any two methods of thrust augmentation. **(08 Marks)**

b. Under take off conditions when the ambient pressure and temperature are 1.01 and 288K, the stagnation pressure and temperature in the jet pipe of a turbojet engine are 2.4 bar and 1000K, and the mass flow is 23Kg/s. Assuming that the expansion in the converging propelling nozzle is isentropic. Calculate the exit area required and thrust produced. For a new version of the engine that thrust is to be increased by the addition of an aft fan which provides a separate cold exhaust stream. The fan has a by-pass ratio of 2.0 and a pressure ratio of 1.75, the isentropic efficiency of the fan and fan-turbine sections being 0.88 and 0.90 respectively. Calculate the take off thrust assuming that the expansion in the cold nozzle is also isentropic, and that the hot nozzle area is adjusted so that the hot mass flow remains at 23Kg/s. **(08 Marks)**

Module-3

5 a. Discuss various types of thrust reverser systems. **(08 Marks)**

b. Briefly explain over expanded and under – expanded nozzles. **(04 Marks)**

c. With a neat diagram, explain boundary layer separation in inlets. **(04 Marks)**

OR

6 a. What are the types of nozzle used in jet engines? List out all the functions of an exhaust nozzle. **(08 Marks)**

b. With the aid of neat diagram, Briefly explain supersonic inlets and list out inlet performance characteristics that are used to assess the performance of supersonic inlets. **(08 Marks)**

Module-4

7 a. With a neat diagram, explain the velocity of a centrifugal flow compressor. **(08 Marks)**

b. A centrifugal compressor takes in gas at 0°C and 0.7 bar and delivers at 1.05 bar. The efficiency of the process compared with the adiabatic compression is 83%. The specific heat of the gas at constant – pressure and constant volume are 1.005 and 0.717respectively. Calculate the final temperature of the gas and work done per kg of gas. If the gas were further compressed by passing through a second compressor having the same pressure ratio and efficiency and with no cooling between the two compressors, what would be the overall efficiency of the complete process? **(08 Marks)**

OR

8 a. Define degree of reaction and derive an expression for axial compression. **(08 Marks)**

b. An axial flow air compressor of 50% reaction design has blades with inlet and outlet angles of 45° and 10° respectively. The compressor is to produce a pressure ratio of 6:1 with an overall isentropic efficiency of 0.85 when inlet static temperature is 37°C. The blade speed and axial velocity are constant throughout the compressor. Assuming a value of 200m/s for blade speed find the number of stages required if the work done factor is i) unity a ii) 0.87 for all stages. **(08 Marks)**

Module-5

9 a. With a neat sketch, explain process of combustion in a gas turbine engine. **(08 Marks)**

b. Gas at 7 bar and 300°C expands to 3 bar in an impulse turbine stage. The nozzle angle is 70° with reference to the exit direction. The rotor blades have equal inlet and outlet angles, and the stage operates with the optimum blade speed ratio. Assuming that the isentropic efficiency of the nozzle is 0.9, and that the velocity at entry to the stage is negligible, deduce the blade angle used and the mass flow required for this stage to produce 75kW. Take C_p = 1.15kJ/Kg K. **(08 Marks)**

OR

10 a. In a single stage impulse turbine the nozzle discharge the fluid on to the blades at an angle of 65° to the axial direction and the fluid leaves the blades with an absolute velocity of 300m/s at an angle of 30° to the axial direction. If the blades have equal inlet and outlet angler and there is no axial thrust, estimate the blade angle, power produced per Kg/s of the fluid and the blade efficiency. **(08 Marks)**

b. Write a shot notes on : i) Flame tube cooling ii) Combustion intensity. **(08 Marks)**

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