Register Number: ……..

B.E., DEGREE EXAMINATIONS: NOV/DEC 2012

Fifth Semester

AERONAUTICAL ENGINEERING

AER109**:** Aircraft Propulsion

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. A helicopter uses
   a) Turboprop b) Turbofan
   c) Turboshaft d) Turbojet
2. Water-injection is a technique for
   a) Thrust augmentation b) Thrust reversal
   c) Flame tube cooling d) Thrust vectoring
3. Acceleration of the aircraft occurs during
   a) Landing b) Take-off
   c) (b) and (d) d) Thrust augmentation
4. The static pressure in a subsonic diffuser
   a) Increases b) Decreases
   c) Increases and then decreases d) Remains constant
5. If the degree of reaction is unity, then
   a) $\Delta p_{rotor}=\Delta p_{stage}$ b) $\Delta p_{rotor}>\Delta p_{stator}$
   c) $\Delta p_{rotor}<\Delta p_{stator}$ d) $\Delta p_{rotor}=0$
6. Wiggle strips are used for
   a) Stall prevention b) Flame tube cooling
   c) Thrust reversal d) Emission reduction
7. Which of the following is not an expansion device?
   a) Turbine b) Nozzle
   c) Diffuser d) Combustion chamber
8. Which of the following does not involve shock in a nozzle
   a) Acceleration beyond the throat in a CD nozzle b) When $P_{exit} < P_{amb}$
   c) When $P_{exit} > P_{amb}$ d) When $P_{exit} = P_{amb}$
9. Which of the following engine requires a compressor
   a) Turbojet b) Scramjet
   c) Ramjet d) Both (b) and (c)

10. Which of the following is not a self starting engine?

a) Turbojet b) Turboshaft

c) Rocket d) Scramjet

PART B (10 x 2 = 20 Marks)

11. List any two advantages of a turboprop engine.
12. How does altitude affect the thrust?
13. Under what conditions, does the diffuser at the inlet stall?
14. Distinguish inlet flow for take off and level operations.
15. Draw the h-s diagram for a single stage of an axial flow compressor.
16. Justify the use of an overall lean air-fuel mixture for a gas turbine engine.
17. What are the methods of turbine blade cooling?
18. What are the types of thrust reversers?
19. List the limitations of a ramjet engine.
20. Draw the exit velocity diagram for a backward curved impeller.

PART C (5 x 14 = 70 Marks)

21. a) (i) Compare turboprop, turbojet and turbofan engines. (6)

(ii) Describe the working of a turbofan engine with illustrative sketches and also draw T-s diagram for ideal and real cycles. (8)

(OR)

b) A turboprop aircraft is flying at 600kmph at an altitude where the ambient conditions are 0.458 bar and -15C. Compressor pressure ratio is 9:1 and the maximum gas temperature is 1200K. The intake efficiency is 0.9 and total head isentropic efficiency of the compressor and turbine are 0.89 and 0.93 respectively. Calculate the specific power output in kJ/kg, thermal efficiency of the unit taking the mechanical efficiency of transmission to be 98%, neglecting the losses other than specified. Assume that exhaust gases leave the aircraft at 600kmph relative to the aircraft.

22. a) (i) Write short notes on starting problems in supersonic inlets and methods to overcome them. (7)

(ii) Explain Super-critical and sub-critical operation of supersonic inlets. (7)

(OR)

b) (i) Flow enters an ideal diffuser with a Mach number of 0.7, an inlet pressure of 0.9046 bar, and at an inlet diameter of 1.0m. If the diffuser operates with the optimum pressure coefficient of 0.6, what is the resulting exit Mach number and diffuser area ratio? Assume isentropic compression with γ=1.4.

23. a) A centrifugal compressor takes in gas at 0°C and 0.7bar and delivers at 1.05 bar. The efficiency of the process compared with adiabatic compression is 83%. The specific heat of the gas at constant pressure and constant volume are 1.005 and 0.717 kg/m^3 respectively. Calculate the final temperature of the gas and workdone per unit mass of gas. If the gas were further compressed by passing through a second compressor having the same pressure ratio and efficiency with no cooling between the compressors, what would be the overall efficiency of the complete process?

(OR)

b) How are gas turbine combustion chambers classified? Explain the three types of combustion chambers with neat sketches. Discuss also the relative merits and demerits.

24. a) (i) What are the two basic types of turbine? Draw the corresponding velocity triangles at inlet and outlet. (8)

(ii) Explain "Vortex Theory". (6)

(OR)

b) (i) Explain the following with a neat sketch ejector and Thrust reversal. (8)

(ii) Describe the phenomenon of under-expansion and over-expansion in nozzles with appropriate diagrams. (6)

25. a) (i) State the functions of aircraft engine nozzle. (8)

(ii) List the losses in a nozzle (3)

(iii) Explain convergent nozzle performance with the help of a simple sketch for various pressure ratios. (3)

(OR)

b) (i) What is meant by scramjet? How does it differ from ramjet? (4)

(ii) What are the design constraints for a scramjet engine? (8)

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