Register Number: ……..

B.E DEGREE EXAMINATIONS: NOV/DEC 2012

Seventh Semester

AERONAUTICAL ENGINEERING

AER129: Combustion Techniques

(Use of Combustion Table is permitted)

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Which of the following combustor has the maximum pressure drop?
   a) Annular b) Can
   c) Can-Annular d) Flame-tube

2. Which of the following is not an air-breathing engine?
   a) Ramjet b) Scramjet
   c) Pulsejet d) None of the above

3. The stoichiometric air-fuel ratio for an aviation fuel is approximately
   a) 15:1 b) 3:1
   c) 25:1 d) 100:1

4. The temperature at the exit of the combustion chamber is affected by
   a) Turbine blade material b) Compression ratio
   c) Air-fuel ratio d) All the above

5. Nature of combustion occurring in reciprocating SI engine is
   a) Intermittent b) Spontaneous
   c) Continuous d) Both a & b

6. The combustion zone responsible for self sustainability of flame in jet engines
   a) Primary zone b) Secondary zone
   c) Tertiary zone d) All of the above

7. Liquid rocket motor combustion flame is an example of
   a) Premixed flame b) Diffusion flame
   c) sustainable flame d) Both b & c

8. _____ involves an exothermic front accelerating through a medium that eventually drives a shock front propagating directly in front of it.
   a) Deflagration b) Detonation
   c) Both a & b d) None of the above

9. _____ is defined as the regression of the burning surface per unit time.

a) burning rate b) burning area

c) solid propellant density d) propellant rate

10. _____in a solid-rocket motor provides a means of heating the surface of the propellant charge to a high enough temperature to induce combustion.

a) Igniter b) Injector

c) Combustor d) Motor

PART B (10 x 2 = 20 Marks)

11. Define: Stoichiometry and Equivalence ratio
12. Define adiabatic flame temperature.
13. What is Burke- Schumann flame?
14. What are the differences between the premixed and diffusion flames?
15. What are the possible causes for detonation in reciprocating engine?
16. Define Combustion efficiency
17. Define blow- off and flashback limit for flames.
18. What are the primary requirements of the combustor
19. What is zero order reaction? Give example.
20. Describe briefly the combustion of carbon particle

PART C (5 x 14 = 70 Marks)

21. a) (i) Briefly explain the laws of thermodynamics (4)

(ii) A gaseous mixture at 1500 K consists of 25% CO, 15% CO_2, 10% H_2, and 5% CH_4 and 50 % N_2 by volume. Find the molecular weight M and specific heat at constant volume, c_v for mixture. (10)

(OR)

b) (i) Derive a Rankine – Hugoniot relation for combustion flame in a closed system. (7)

(ii) A closed system contains 1000 ppm of CO , 3% O_2 and remaining N_2 at 1500 K and 1 atm pressure. Determine the time taken for 90% of CO to undergo reaction as per the chemical equilibrium reaction given below. (7)

$$CO + O_2 \leftrightarrow CO_2 + O$$

Assume equilibrium constant , k = 2.5 x 10 exp(-24060 / T) g mol^{-1} m^{-3} s^{-1}

22. a) (i) Explain in detail about any two techniques for measuring premixed flame velocity with a neat sketch. (7)

(ii) A laminar butane gas jet issued from a tube into the air has a flame height of 10 cm. Determine the volumetric fuel flow rate and heat release rate. If the fuel tube diameter is increased by 25 % and velocity is increased by 25 %, What will be the flame height? Take heat of combustion of butane gas = 45000 kJ/kg, T_{ad} = 2300 K. (7)

(OR)

b) List out the assumptions made in laminar flame theory? and Derive an expression for burning velocity of a flame.

23. a) Explain the detonation in reciprocating engines and Explain in detail about the prevention techniques for detonation in reciprocating engine.

(OR)

b) (i) Explain the factors affecting the combustion process in piston engines? (7)

(ii) Describe briefly the operation of reciprocating engine. (7)

24. a) Explain the different types of combustors in the gas turbine engines with necessary sketches and also list out its relative advantages and disadvantages

(OR)

b) (i) Explain the recirculation and flame stabilization in main combustor (7)

(ii) Write short notes on Afterburners (7)

25. a) Explain in detail the basic principles of combustion process of solid propellant rockets with neat sketches

(OR)

b) (i) With a neat sketch, explain in detail about droplet combustion in liquid propellant rockets. (10)

(ii) Write short notes on boundary layer combustion (4)

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