Register Number:……..

KUMARAGURU college of technology
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**B.E DEGREE EXAMINATIONS : MAY 2018**

(Regulation 2015)

Sixth Semester

**AERONAUTICAL ENGINEERING**

U15AEE007 : Wind Tunnel Techniques

**COURSE OUTCOMES**

**CO1:** Design low speed / high speed wind tunnel.

**CO2:** Apply the calibration technique on a wind tunnel.

**CO3:** Design the model as per the wind tunnel requirement.

**CO4:** Use various instruments for measuring the flow properties.

**CO5:** Use optical instruments to predict the shock wave characteristics.

**CO6:** Predict flow characteristics using flow visualization techniques.

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

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Matching type item with multiple choice code CO1 [$K_2$]

| List I | List II |
|---|---|
| A. Reynolds number | i. Inertia force and elastic force |
| B. Froude number | ii. Inertia force and surface tension force |
| C. Weber number | iii. Inertia force and gravity force |
| D. Mach number | iv. Inertia force and viscous force |

| | A | B | C | D |
|---|---|---|---|---|
| a) | ii | i | iii | iv |
| b) | iv | iii | ii | i |
| c) | ii | iv | iii | i |
| d) | iii | i | iv | ii |

2. Which one of the dimensionless numbers identifies the compressibility effect of a fluid? CO1 [$K_1$]

a) Euler number b) Froude number

c) Mach number d) Weber number

3. Consider the following statements: CO2 [$K_1$]

1. For achieving dynamic similarity in model studies on ships, Froude numbers are equated.
2. Reynolds number should be equated for studies on aerofoil for dynamic similarity.
3. In model studies on a spillway, the ratio of width to height is equated for kinematic similarity.

What of the statements given above are correct?

a) 1, 2 and 3 b) 1 and 2

c) 2 and 3 d) 1 and 3

4. Which of the following flow visualization method is employed for fields with strong shock waves CO5 [$K_1$]

a) Smoke flow visualization b) Interferometer

c) Schlieren technique d) Shadowgraph method

5. Assertion (A): Maximum model cross-section area (projected area of the model, normal to the test-section axis) of the order of 4 per cent of the test-section area is quite common for supersonic tunnels. CO3 [$K_2$]

Reason (R): Model size is limited by tunnel chocking and wave reflection considerations.

a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A

c) A is true but R is false d) A is false but R is true

6. According to King's law for a constant temperature Hot-wire anemometer CO4 [$K_2$]

a) $E \propto U$ b) $E^2 \propto U$

c) $E^2 \propto$ d) $E \propto U^2$

7. A simple Pitot tube can be used to measure which of the following quantities? CO4 [$K_1$]

1. Static head 2. Datum head 3. Dynamic head 4. Friction head 5. Total head

Select the correct answer using the codes given below

a) 1, 2 and 4 b) 1,3 and 5

c) 2, 3 and 4 d) 2, 3 and 5

8. In supersonic wind tunnel design, an oblique shock diffuser is preferred over a normal shock diffuser because CO2 [$K_1$]

a) It reduces total pressure loss b) The flow is slowed down more rapidly

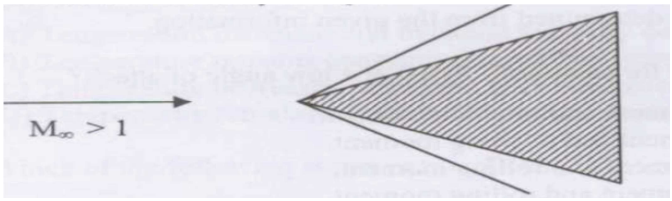
c) The flow is accelerated more rapidly d) It increases total pressure loss

9. Assertion (A): Reynolds number must be same for the model and prototype immersed in subsonic flows. CO1 [$K_1$]

Reason (R): Equality of Reynolds number for the model and prototype satisfies the dynamic similarity criteria.

a) Both A and R are Individually true and R is the correct explanation of A
b) Both A and R are Individually true but R is not the correct explanation of A
c) A is true but R is false
d) A is false but R is true

10. Consider a 2-D body in supersonic flow with an attached oblique shock as shown below CO4 [$K_1$]




An increase in free stream Mach number will cause the oblique shock wave to

a) Move close to the body
b) Move away from the body
c) Detach from the body
d) Become a normal shock

**PART B (10 x 2 = 20 Marks)**
**(Answer not more than 40 words)**

11. What is scale effect and how it is related to the similarities. CO1 [$K_2$]
12. List out the forces acting on a fluid flow. CO1 [$K_2$]
13. What is meant by liquefaction in supersonic wind tunnels? CO1 [$K_2$]
14. Define horizontal buoyancy. CO2 [$K_2$]
15. Mention the various losses in a low speed wind tunnel. CO2 [$K_2$]
16. State the principle of manometer? List out the pressure measuring devices. CO3 [$K_2$]
17. How turbulence can be measured by using the turbulence sphere? CO3 [$K_2$]
18. What are the limitations of dye injection method for flow visualization? CO4 [$K_2$]
19. What is the need for cryogenic wind tunnel? CO5 [$K_2$]
20. Why air heaters required in hypersonic wind tunnels? CO5 [$K_2$]

**Answer any FIVE Questions:-**
**PART C (5 x 14 = 70 Marks)**
**(Answer not more than 300 words)**

**Q.No. 21 is Compulsory**

21. Describe the types of wind tunnel balances. What are the six components measured by the wind tunnel balances? Explain how these are measured. CO2 [$K_3$]

| | | | | |
|---|---|---|---|---|
| 22. | (i) Write any three non-dimensional numbers used for aerodynamics and their importance. | (7) | CO1 | [$K_3$] |
| | (ii) Write the types of similarities and explain each in detail with examples. | (7) | CO1 | [$K_3$] |
| 23. | Explain in detail any two types of wind tunnels with neat sketches and also discuss its advantages and disadvantages. | | CO2 | [$K_3$] |
| 24. | (i) State the principle of Hot-Wire Anemometer. Explain the constant temperature mode of operation of Hot-Wire Anemometer with neat circuit. | (7) | CO4 | [$K_4$] |
| | (ii) Explain the starting problem and starting loads in high speed wind tunnels. | (7) | CO4 | [$K_3$] |
| 25. | (i) What is the purpose of calibration of wind tunnel? How the wind tunnel test section speed and horizontal buoyancy is calibrated? | (7) | CO2 | [$K_4$] |
| | (ii) Explain how the sphere type yaw meter is employed for measuring the flow angularity? | (7) | CO2 | [$K_3$] |
| 26. | Give a description of the shadowgraph and schlieren techniques. What are the main differences between the two techniques? | | CO5 | [$K_3$] |
| 27. | Explain the following with neat sketches: (i) Helium tunnel, (ii) Gun tunnel and (iii) Shock tubes. | | CO6 | [$K_4$] |

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