

**III B.Tech I Semester Regular Examinations, November 2005**  
**WIND TUNNEL TECHNIQUES**  
**(Aeronautical Engineering)**

**Time: 3 hours**

**Max Marks: 80**

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. The drag force on a 2-D flat plate model depends upon the relative velocity  $V$ , chord  $C$ , properties of the air medium like density and viscosity, apart from its angle of attack. Obtain a set of PI groups that can be used to correlate the experimental data. [16]
2. It is proposed to build a class room wind tunnel to be placed on a table top for demonstrating fundamentals of aerodynamics and wind tunnel design and testing. Frame the specifications and work out a design layout in this case. Try to be as economical as possible with the aims and objective not to be compromised. [16]
3. It is proposed to make use of de-commissioned jet engines for creating a supersonic facility in your institute. Describe your plans with sketches and aerodynamics involved. [16]
4. Define the terms Turbulence and Turbulence factor in a wind tunnel having closed test section. What are the ways and means of measuring turbulence in a wind tunnel? Illustrate with the instrumentation used. [16]
5. Explain the principle, functioning and use of a pressure transducer in measuring pressure in wind tunnels. Hence describe one such pressure recording device in details with sketches. [16]
6. Describe a simple external type strain gauge balance; to be used with a model mount for a missile model for low speed wind tunnel testing. Explain all details with appropriate illustrations. [16]
7. What are the principals and requirements of visualizing a flow field in a low speed wind tunnel? Name different techniques along with their specific merits over others. Hence describe one such technique for observing stalling behavior of a finite span wing mounted on a sting in the test section of a low speed wind tunnel. Illustrate what you obtain with sketches and plots. [16]
8. Explain the Dye Injection technique of flow visualization in wind tunnel testing. How far is this technique superior to any other flow viewing method? Provide its application with one example and illustrate it with good sketches and plots. [16]

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1. What is the importance of the terms Flow similarity on model studies in wind tunnel testing? How does the geometric similarity contribute for the solution to be realistic? State the PI theorem and explain the procedure for determining PI groups for a problem under planning for some testing. [16]
2. What is understood by the term low speed wind tunnel in aerodynamic testing? Describe with brief details through sketches and plots, various types of low speed wind tunnels based upon the test section details. Hence explain a closed section, open ckt wind tunnel with all details. [16]
3. How does a supersonic tunnel differ from a sub-sonic wind tunnel in its function, looks and layout? Explain by showing both the layouts with good sketches. [16]
4. Consider a test section of a wind tunnel with height  $h$  and width  $w$ . A 2D wing spanning the test section has its front part made of a semi cylinder of radius  $r$  and the maximum dimension of  $2*r$  varies linearly to zero over a distance  $d$ , where  $d = 5*r$ . Estimate the additional drag occurring on the model due to horizontal buoyancy. [16]
5. Describe the basis for the measurement of pressure and instruments used for the purpose. What are its advantages and applications? Illustrate with theory and an example. Hence explain one method of measuring all parameters in the flow past a stationary circular cylinder kept in a uniform stream of air in a wind tunnel. [16]
6. A wire type balance is to be prepared and used for measuring three forces and three moments on a model airplane. Propose a scheme such that the reliability of the arrangement is not spoiled. Make use of sketches and plots in this respect. [16]
7. What are the Principals and requirements of visualizing a flow field in a low speed wind tunnel? Name different techniques along with their specific merits over others. Hence describe one such technique for observing stalling behavior of a 2D wing spanning the test section of a low speed wind tunnel. Illustrate what you obtain with sketches and plots. [16]
8. Explain the superiority of oil flow visualization technique over some other surface flow visualization techniques. What are the factors that contribute to realistic results from this technique? Apply this method for viewing flow over a circular cylinder and present the results in the form of good sketches. [16]

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1. What is the significance of non dimensional parameters in aerodynamic testing? Explain the importance and effect of Euler number on aerodynamic characteristics of a model under testing in a wind tunnel. Hence state the PI theorem and work out dimensionless groups upon which depend the aerodynamic characteristics of a model under tests in a wind tunnel. [16]
2. Establish the necessity of a diffuser in a low speed suction type wind tunnel. What is the optimum location of such a diffuser and how does it interfere with the flow characteristics in the test section and life cycle of the wind tunnel fan? Illustrate with sketches and diagrams. [16]
3. Why should the test section of a transonic wind tunnel be with perforated walls? Hence show with sketches and diagrams an arrangement of a transonic tunnel. [16]
4. Write notes on
  - (a) Setting Mach number in a transonic wind tunnel,
  - (b) Measurement of turbulence level in a transonic wind tunnel. [16]
5. Describe the basis for the measurement of pressure and instruments used for the purpose. What are its advantages and applications? Illustrate with theory and an example. Hence explain one method of measuring all parameters in the flow past a rotating circular cylinder kept in a uniform stream of air in a wind tunnel. [16]
6. It is proposed to measure drag force on the model of a road vehicle .Device a simple and reliable mechanism to fulfill the aim. All details be submitted along with sketches / diagrams. [16]
7. Describe a smoke generating technique using kerosene for producing smoke in a smoke tunnel. Utilize this technique for observing flow over a circular cylinder spanning the test section. Produce a realistic looking record for explaining the phenomenon of separation of flow to students in the laboratory; with good sketches. Is there any limitation of speed? [16]
8. Explain the superiority of oil flow visualization technique over some other surface flow visualization techniques. What are the factors that contribute to realistic results from this technique? Apply this method for viewing stalled flow over a finite span wing model; stings mounted in the test section with pitch-changing mechanisms and present the results in the form of good sketches. [16]

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1. Explain the dynamic similarity between a wind tunnel model and the prototype to be flight tested. What are the essential conditions to be satisfied for the results to be carried from the model to the prototype? Are there any limitations or pre-conditions involved? Explain with sketches and plots by considering a 2 D wing model at moderate angle of attack. Will these results hold for higher angles of attack as well? [16]
2. What is understood by the term low speed wind tunnel in aerodynamic testing? Describe with brief details through sketches and plots, various types of low speed wind tunnels based upon the details of the flow in test section. Hence explain an open section, suction type wind tunnel with all details. [16]
3. Explain the necessity of pre-heated compressed air stream for a hypersonic wind tunnel. Hence describe in details a hypersonic wind tunnel. [16]
4. Write notes on
  - (a) Setting Mach number in a transonic wind tunnel,
  - (b) Measurement of turbulence level in a transonic wind tunnel. [16]
5. Describe the basis for the measurement of pressure and instruments used for the purpose. What are its advantages and applications? Illustrate with theory and an example. It is desired to obtain pressure distribution aft of a rotating circular cylinder kept in the test section of a wind tunnel. Explain the methodology and show a sample plot with good sketches. [16]
6. What types of wind tunnel balances are used to ascertain forces and moments on an airplane model in a low speed wind tunnel? Hence describe the underlying principles of an external type wind tunnel balance for measuring lift, drag and pitching moments over a finite span wing. Provide all details with sketches and plots. [16]
7. Explain the phenomenon of separation of flow over a 2D wing with the help of liquid paraffin generated smoke wire technique with good sketches. What are its merits over kerosene generated smoke? [16]
8. Explain the superiority of oil flow visualization technique over some other surface flow visualization techniques. What are the factors that contribute to realistic results from this technique? Apply this method for viewing flow over a 2D wing model spanning the test section and present the results in the form of good sketches. [16]

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