INSTITUTEOFAERONAUTICALENGINEERING

(Autonomous)
Dundigal, Hyderabad-500043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**EXPERIMENTAL AERODYNAMICS**
Course Code	:	**AAE509**
Class	:	VI Semester
Branch	:	AERO
Year	:	2019 – 2020
CourseCoordinator	:	Dr.Prasanta Kumar Mohanta, Professor
Course Faculty	:	Dr.Prasanta Kumar Mohanta, Professor

OBJECTIVES

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

I. COURSE OBJECTIVES (COs):

The course should enable the students to:

I	Fundamentals of Aerodynamics experiments, their need in comparison with numerical computation and theoretical studies.
II	Develop concepts of flow similarity and evaluate the loss coefficients of wind tunnel components. Analyze the concept of force and moment measurements using wind tunnel balance and extrapolate it to new balance development.
III	Summarize various techniques for pressure, velocity, temperature measurement and flow visualization

II. COURSE LEARNING OUTCOMES (CLOs):

At the end of the course, the student will have the ability to:

CLO Code	CLO's	Description
AAE509.01	CLO 1	Wind tunnel experimental test and measuring techniques
AAE509.02	CLO 2	Development of wind tunnel experimental test
AAE509.03	CLO 3	Types of Wind tunnels and their requirements will help the students to design and application
AAE509.04	CLO 4	Wind tunnels for industrial and various applications apart from aerospace requirements

CLO Code	CLO's	Description
AAE509.05	CLO 5	Requirements for quality assurance in testing methodology
AAE509.06	CLO 6	Experimental requirements and design constraints
AAE509.07	CLO 7	Wind tunnel quality and performance
AAE509.08	CLO 8	Source of errors and correction methodology
AAE509.09	CLO 9	Usage and need of wind tunnel balance
AAE509.10	CLO 10	Models mounting techniques
AAE509.11	CLO 11	Various techniques used in wind tunnels for flow visualization
AAE509.12	CLO 12	Schlieren system and set up
AAE509.13	CLO 13	Merits and demerits of various flow visualization techniques
AAE509.14	CLO 14	Right tools and techniques for required flow speed
AAE509.15	CLO 15	Flow measurements techniques for steady
AAE509.16	CLO 16	Flow measurements techniques for unsteady flow
AAE509.17	CLO 17	Usage of electronic device and transducer
AAE509.18	CLO 18	Usage of hot wire Anemometry
AAE509.19	CLO 19	Usage of electronic device and transducer
AAE509.20	CLO 20	Flow visualisation of subsonic and supersonic flow

TUTORIAL QUESTION BANK

S No	QUESTION	Blooms Taxonomy Level	Course Outcomes (CO)	Course Learning Outcomes
UNIT– I **FUNDAMENTALS OF EXPERIMENTS IN AERODYNAMICS**				
Part - A(Short Answer Questions)				
1	Define the main objectives of aerodynamic experiments.	Remember	CO 1	AAE509.1
2	Explain the procedure of selecting model for aerodynamic observations.	Understand	CO 1	AAE509.2
3	Explain Classify various types of wind tunnel used for Aerodynamic studies.	Understand	CO 1	AAE509.3
4	What are the basic principles for wind tunnel selection?	Understand	CO 1	AAE509.3
5	What do you mean by model scaling?	Understand	CO 1	AAE509.5
6	What do you mean by a transonic wind tunnel?	Remember	CO 1	AAE509.4

7	What are the scaling parameters?	Remember	CO 1	AAE509.3
8	Explain the term dynamic similarity.	Remember	CO 1	AAE509.5
9	Explain the term geometric similarity.	Remember	CO 1	AAE509.5
10	What are the various area of aerodynamic experiments are employed.	Remember	CO 1	AAE509.5
Part - B (Long Answer Questions)				
1	Write the significance of aerodynamic experiments in comparison to numerical analysis and theoretical solution.	Remember	CO 1	AAE509.6
2	Briefly, describe the method of observation for aerodynamic experiments.	Understand	CO 1	AAE509.8
3	Discuss the scaling laws used in aerodynamic modelling.	Remember	CO 1	AAE509.5
4	Write the importance of scale down model and it'srelation to prototype.	Remember	CO 1	AAE509.5
5	Explain Buckingham pi theorem with example	Understand	CO 1	AAE509.5
6	Suggest the methodology on model design and relatedprecaution.	Remember	CO 1	AAE509.10
7	Write the parameters used on scaling law. Explain aboutgeometrical similarities.	Understand	CO 1	AAE509.5
8	What are the significance of similarity parameters? Explainany one parameter and its relation with experimentation.	Understand	CO 1	AAE509.5
9	Suggest some outcome from aerodynamic testing in relation to design of airplane.	Understand	CO 1	AAE509.6
10	What are the essential conditions to be satisfied for theresults to be carried from the model to the prototype?Are there any limitations or preconditions involved?	Remember	CO 1	AAE509.5
Part - C (Problem Solving and Critical Thinking Questions)				
1	What are the different types of supersonic wind tunnel?	Analyze	CO 1	AAE509.3
2	Consider a Boeing 747 airliner cruising at a velocity of 885 km/h at a standard altitude of 11.58 km, where the freestream pressure and temperature are 20.712 kPa and 216.67K, respectively. A one-fiftieth scale model of the 747 is tested in a wind tunnel where the temperature is 239K. Calculate the required velocity and pressure of the test airstream in the wind tunnel such that the lift and drag coefficients measured for the wind-tunnel model are the same as for free flight. Assume that both μ and a are proportional to $T^{1/2}$	Evaluate	CO 1	AAE509.5
3	Discuss the classification of wind tunnels in detail.	Evaluate	CO 1	AAE509.3
4	An open jet test-section of a subsonic wind tunnel expands freely into a still environment. The test-section length is 1.5 times the diameter of the contraction cone exit. The friction coefficient for the free jet is 10 times that of the closed throat with smooth wall. If the friction coefficient of the smooth wall is 0.008, determine the increase of loss when the jet is open, treating the jet as a cylindrical duct.	Evaluate	CO 1	AAE509.2
5	Explain the dynamic similarity between a wind tunnelmodel and the prototype to be flight-tested. What are theessential conditions to be satisfied for the results to becarried from the model to the prototype? Are there anylimitations or preconditions involved?	Remember	CO 1	AAE509.3
6	An open circuit subsonic wind tunnel of test-section 1.2 m X 0.9 m is run by a 110 kW motor. If the test-section speed is 90 m/s, calculate the energy ratio of the tunnel. Also, find the	Evaluate	CO 1	AAE509.2

	total loss in the tunnel in terms of test-section kinetic energy. Take the air density as the standard sea level value.			
7	Define the following non-dimensional numbers: force coefficient, Euler number, Reynold's number and moment coefficient. How do the model scale effects influence the wind tunnel test results?	Remember	CO 1	AAE509.2
8	List industrial domain where wind and fluid tunnels are used.	Evaluate	CO 1	AAE509.4
9	Determine the minimum possible diffuser contraction ratio and the power required for a two-stage compressor to run a closed-circuit supersonic tunnel at M = 2.2. The efficiency of the compressor is 85 percent, p_{01} = 4 atm, T_0 = 330K and ATS = 0.04m^2.	Evaluate	CO 1	AAE509.3
10	Briefly explain the types of non-dimensionless number.	Evaluate	CO 1	AAE509.3
UNIT-II **WIND TUNNEL EXPERIMENTATION CONSIDERATIONS**				
Part – A (Short Answer Questions)				
1	What is function of diffuser?	Remember	CO 2	AAE509.6
2	What is function of effuse/contraction?	Remember	CO 2	AAE509.6
3	Classify the wind tunnels.	Understand	CO 2	AAE509.6
4	What are the merits and demerits of open circuit?	Remember	CO 2	AAE509.7
5	Define Energy Ratio.	Remember	CO 2	AAE509.7
6	Draw neat sketch of low speed wind tunnel.	Remember	CO 2	AAE509.3
7	What are sources of error and uncertainties in wind tunnel?	Understand	CO 2	AAE509.8
8	What is solid blockage?	Remember	CO 2	AAE509.8
9	What is wake blockage?	Remember	CO 2	AAE509.8
10	What is meant by zero lift drag?	Remember	CO 2	AAE509.10
11	What are the causes of streamline curvature?	Understand	CO 2	AAE509.10
Part - B (Long Answer Questions)				
1	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.	Understand	CO 2	AAE509.3
2	What are the classifications of wind tunnel?	Understand	CO 2	AAE509.3
3	Discuss in detail the effect of flow quality in wind tunnel performance.	Remember	CO 2	AAE509.7
4	What are the components of low speed wind tunnel?Explain in detail any two of them.	Understand	CO 2	AAE509.3
5	What are the design requirements and constrictions of Low speed wind tunnels?	Understand	CO 2	AAE509.5
6	Discuss about the construction of Low speed windtunnels. Explain in detail the loss coefficients in them.	Understand	CO 2	AAE509.5
7	Explain the purpose of the following: a) Diffuser b) straighteners c) honeycombs d) contraction cone and e) turning vanes	Remember	CO 2	AAE509.5
8	What is boundarylayer correction in the test sectiondesign of	Analyze	CO 2	AAE509.11

	wind tunnels?			
9	With a neat illustration, explain the objective ofcalibration of a wind tunnel. In what way the calibrationprocedure for a supersonic tunnel different from that of a subsonic wind tunnel.	Remember	CO 2	AAE509.11
10	Discuss the causes, estimation and correction ofstreamline curvature.	Understand	CO 2	AAE509.10
11	Discuss in detail the wind tunnel corrections and theneed for wind tunnel corrections.	Analyze	CO 2	AAE509.11
12	Discuss in detail the corrections on airspeed and dynamicpressure.	Understand	CO 2	AAE509.11
Part – C (Problem Solving and Critical Thinking)				
1	Explain the losses in subsonic wind tunnel.	Understand	CO 2	AAE509.5
2	Derive the equation for test section speed in low speedwind tunnel and draw the corresponding curve	Evaluate	CO 2	AAE509.5
3	Explain the operation, merits, demerits and application of any three special purpose wind tunnels.	Understand	CO 2	AAE509.4
4	On what factors does the pressure loss in a constant area cross section duct depend on?	Evaluate	CO 2	AAE509.5
5	On what factors does pressure loss in a diffuser depend on? Explain it qualitatively.	Evaluate	CO 2	AAE509.8
6	On what factors does pressure loss in a Honeycomb & screens depend on? Explain it qualitatively.	Evaluate	CO 2	AAE509.8
7	Determine the running time for a Mach 2 blowdown wind tunnel with test-section cross-section of 300 mm X300 mm. The storage tank volume is 20 m3 and the pressure and temperature of air in the tank are 20 atm and 25^0C, respectively. The tank is provided with a heat sink material inside. Take the starting pressure ratio required for Mach 2.0 to be 3.0, the loss in pressure regulating valve (PRV) to be 50 percent, and the polytropic index n = 1.0.	Remember	CO 2	AAE509.6
8	Why a drive system is required in a wind tunnel? Why Can't the wind tunnel have a sustained flow with just a convergent-test section- diffuser arrangement?	Evaluate	CO 2	AAE509.3
9	Is it not feasible to have a constant area test section with a fan at the exit? Why has the present day convergent-constant area- diffuser configuration has evolved?	Evaluate	CO 2	AAE509.6
10	Find the test-section temperature for a hypersonic stream of air at Mach 7 with stagnation temperature at 700 K.	Evaluate	CO 2	AAE509.6
UNIT-III **WIND TUNNEL BALANCE**				
Part - A(Short Answer Questions)				
1	Explain the transonic wind tunnel with neat sketch.	Remember	CO 3	AAE509.3
2	Draw and depict the various parts of Supersonic wind tunnel?	Understand	CO 3	AAE509.3
3	What is hypersonic wind tunnel?	Understand	CO 3	AAE509.3
4	How blow down wind tunnel is different from suction type wind tunnel?	Understand	CO 3	AAE509.3
5	What are the losses in wind wind tunnels?	Understand	CO 3	AAE509.3
6	What are the advantages of Blow down type wind tunnels?	Understand	CO 3	AAE509.3
7	Draw and illustrate the various components of a shock tube?	Remember	CO 3	AAE509.3
8	Make a neat sketch of a shock tunnel?	Remember	CO 3	AAE509.3

9	What are the disadvantages of Blow down type wind tunnels?	Understand	CO 3	AAE509.3
10	What are the classifications of wind tunnel?	Remember	CO 3	AAE509.3
11	List the types of loads measuring techniques in wind tunnel?	Understand	CO 3	AAE509.9
12	What is meant by wind tunnel balance?	Understand	CO 3	AAE509.9
13	Describe wind tunnel balance.	Remember	CO 3	AAE509.9
14	Why do we need load measurements?	Understand	CO 3	AAE509.9
15	What are the types of wind tunnel balances?	Remember	CO 3	AAE509.9
Part – B (Long Answer Questions)				
1	Sketch the typical layout of a supersonic wind tunnel and mark all the components and subsystems. What is starting problem in supersonic tunnels?	Understand	CO 3	AAE509.3
2	What is meant by subsonic and transonic speed regime?	Remember	CO 3	AAE509.3
3	What are the losses in supersonic tunnel?	Remember	CO 3	AAE509.8
4	Compare the difference between subsonic, supersonic and hypersonic wind tunnel.	Understand	CO 3	AAE509.3
5	Explain six component balance with neat sketch?	Evaluate	CO 3	AAE509.9
6	Mention the features and characteristics of wind tunnel balance.	Understand	CO 3	AAE509.9
7	Distinguish between internal and external wind tunnel balances.	Understand	CO 3	AAE509.9
8	Briefly, explain how force measurements are carried out using an external strain gauge balance?	Evaluate	CO 3	AAE509.9
9	Briefly, write the essential features of a strain gauge basedSix-component internal wind tunnel balance.	Remember	CO 3	AAE509.9
10	Explain how the six components are measured using the balance?	Evaluate	CO 3	AAE509.9
Part – C (Problem Solving and Critical Thinking)				
1	Explain the operation, merits, demerits and application ofsupersonic and aero acoustic tunnel.	Evaluate	CO 3	AAE509.3
2	Briefly, explain the special purpose hypersonic windTunnel?	Evaluate	CO 3	AAE509.3
3	Explain the operation Gun tunnel and Shock tunnel?	Evaluate	CO 3	AAE509.6
4	With a neat illustration, explain the objective of calibration of a wind tunnel. In what way the calibration procedure for a supersonic tunnel different from that of a subsonic wind tunnel.	Evaluate	CO 3	AAE509.7
5	What types of wind tunnel balances are used to ascertain forces and moments on an airplane model in a low speed wind tunnel?	Evaluate	CO 3	AAE509.10
6	Describe the underlying principles of an external type wind tunnel balance for measuring lift, drag and pitching moments over a finite span wing.	Evaluate	CO 3	AAE509.10
7	How wind tunnel balances are classified?	Evaluate	CO 3	AAE509.10
8	Explain wire type balance with neat sketch and mention the merits and demerits?	Evaluate	CO 3	AAE509.10
9	Explain the functioning of shock tube and parameters that dictate the stagnation condition.	Analyze	CO 3	AAE509.12
10	Explain the purpose of heater in the settling chamber and second throat in the supersonic wind tunnel.	Remember	CO 3	AAE509.11
UNIT-IV **PRESSURE, VELOCITY & TEMPERATURE MEASUREMENT**				

Part – A (Short Answer Questions)				
1	What do you meant by LDA?	Remember	CO 4	AAE509.11
2	What do you meant by PIV?	Remember	CO 4	AAE509.11
3	What is hot wire anemometry?	Remember	CO 4	AAE509.18
4	What is data processing?	Remember	CO 4	AAE509.19
5	How pressure sensitive paints work?	Evaluate	CO 4	AAE509.16
6	Name few equipment to measure velocity	Remember	CO 4	AAE509.16
7	Name few equipment to measure pressure	Apply	CO 4	AAE509.14
8	Name few equipment to measure Temperature	Remember	CO 4	AAE509.15
9	How are the surface streamlines measured in wind tunnels?	Evaluate	CO 4	AAE509.15
10	How are the turbulence measured in wind tunnels?	Understand	CO 4	AAE509.18
Part – B (Long Answer Questions)				
1	Describe the basis for the measurement of pressure andInstruments used for the purpose. What are its advantages and applications? Illustrate with mathematical theory.	Remember	CO 4	AAE509.17
2	Explain how the surface streamlines measured in wind tunnels.	Understand	CO 4	AAE509.14
3	Explain Turbulence intensitymeasurementsin wind tunnel test section.	Remember	CO 4	AAE509.14
4	Explain how to measure velocity of flow using LDA technique?	Understand	CO 4	AAE509.19
5	What is the basic principle behind hot wire anemometer?What are its limitations?	Remember	CO 4	AAE509.17
6	Explain with a neat sketch the working of a hot wireanemometer.	Understand	CO 4	AAE509.18
7	Describe Particle Image Velocimetry and explain itsworking principle?	Apply	CO 4	AAE509.19
8	Describe the experimental setup, calibration andmeasurement in Particle Image Velocimetry.	Remember	CO 4	AAE509.11
9	Describe various pressure transducers and their concepts underlying their measurement.	Remember	CO 4	AAE509.11
10	Describe Pressure sensitive paints and their applications.	Evaluate	CO 4	AAE509.13
Part – C (Problem Solving and Critical Thinking)				
1	What is meant by LDA? How is velocity measured of flow using LDA technique?	Understand	CO 4	AAE509.15
2	What is meant by PIV? What are the limitations?Explain the working principle of PIV?	Remember	CO 4	AAE509.19
3	What are the important assumptions in the principle of operation of hot wire anemometry, thus limitations of this technique? Why l/d of the hot wire probe very large?	Remember	CO 4	AAE509.18
4	What is the basic principle behind hot wireanemometer? What are its limitations? Explain with aneat sketch the working of a hot wire anemometer.	Create	CO 4	AAE509.18
5	Why are hot wire anemometers preferred for measurement in the low velocity regimes?How are the two modes of hot wire anemometry different from each other?	Evaluate	CO 4	AAE509.18
6	Explain the techniques used for Turbulencemeasurements in a wind tunnel.	Create	CO 4	AAE509.16
7	Write notes on: (a) setting Mach number in a transonic wind tunnel	Evaluate	CO 4	AAE509.12

	(b) Measurements of turbulence in tunnel. Explain the techniques used for turbulence measurements in a wind tunnel. level in a transonic wind			
8	What is the purpose served by the seeding particles in LDA measurements? Derive the classical equation connecting the velocity and the Doppler frequency.	Evaluate	CO 4	AAE509.16
9	Why is the photo receiver in LDA system kept at small angle to the direction of the incident beam?Differentiate between the backward and forward scattering modes of LDA.	Evaluate	CO 4	AAE509.16
10	What component in LDA systems help determining the direction of the flow?What is understood by the fringe model of LDA.	Remember	CO 4	AAE509.16
11	What are the advantages of laser Doppler anemometry for velocity measurements?Compare and contrast LDA with hotwire anemometry?	Remember	CO 4	AAE509.16
12	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 of a rotating circular cylinder kept in the test section of awind tunnel.	Evaluate	CO 4	AAE509.11
UNIT-V **FLOW VISUALIZATION TECHNIQUES**				
Part - A (Short Answer Questions)				
1	Write short notes on the classification of flow visualization Techniques.	Evaluate	CO 5	AAE509.13
2	What are optical flow visualization techniques?	Remember	CO 5	AAE509.13
3	What is surface flow visualization technique?	Remember	CO 5	AAE509.13
4	What is flow visualization techniques?	Remember	CO 5	AAE509.13
5	What are hydrogen bubble and smoke visualization techniques?	Remember	CO 5	AAE509.13
6	What is the technique adopted to visualize Shock waves?	Understand	CO 5	AAE509.12
7	What is china clay visualization?	Remember	CO 5	AAE509.13
8	What are tufts? How are mini tufts better than tufts?	Remember	CO 5	AAE509.13
9	Draw a schematic of the schlieren system making use of concave mirrors marking the components and the test section	Understand	CO 5	AAE509.12
10	What is Shadowgraph technique?	Remember	CO 5	AAE509.11
11	Why the bow shock visualized through shadowgraph has bright and dark bands?	Understand	CO 5	AAE509.13
Part - B (Long Answer Questions)				
1	Explain the classification of flow visualization techniques.	Understand	CO 5	AAE509.11
2	Explain the optical flow visualization techniques.	Understand	CO 5	AAE509.11
3	Explain surface flow visualization technique.	Apply	CO 5	AAE509.11
4	Explain the data flow visualization techniques.	Remember	CO 5	AAE509.11
5	Describe various flow field visualization techniques	Remember	CO 5	AAE509.11
6	Discuss the smoke and tuft grid techniques used for flow Visualization.	Remember	CO 5	AAE509.12
7	Explain in detail schilerin technique.	Create	CO 5	AAE509.12
8	Explain in detail shadowgraphy technique.	Remember	CO 5	AAE509.12
9	How are the imagery of schlieren and shadowgraph different in interpretation?	Understand	CO 5	AAE509.12

10	Explain the interferometric principle.	Understand	CO 5	AAE509.12
Part – C (Problem Solving and Critical Thinking)				
1	What are the requirements of tracer particles used for flow visualization?Why tracer methods cannot be used for visualization of compressible flows?	Evaluate	CO 5	AAE509.11
2	What are the advantages of flow visualization methods? What is the basic principle involved in the interferometer method of flow visualization?	Evaluate	CO 5	AAE509.11
3	What is the basic principle involved in the dye injection Method of flow visualization? What are the limitations of dye injection method for flow visualization?	Evaluate	CO 5	AAE509.13
4	What is the need of flow visualization techniques? Briefly explain the optical methods used for flow visualization	Evaluate	CO 5	AAE509.14
5	With neat illustration, explain the basic principles of Schelieren method of flow visualization. What are the advantages and limitations of the method??	Evaluate	CO 5	AAE509.12
6	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?	Evaluate	CO 5	AAE509.11
7	On what factors does the sensitivity of interferometer depend?	Evaluate	CO 5	AAE509.15
8	Why the lenses/mirrors used in schlieren system has large focal length.	Evaluate	CO 5	AAE509.12
9	What is Gladstone-Dale equation? How does it explain the deflection of a lightRay in a compressible medium?	Evaluate	CO 5	AAE509.12
10	Differentiate the three optical methods schlieren, shadowgraph and interferometry and their relative advantage over each other	Evaluate	CO 5	AAE509.12

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