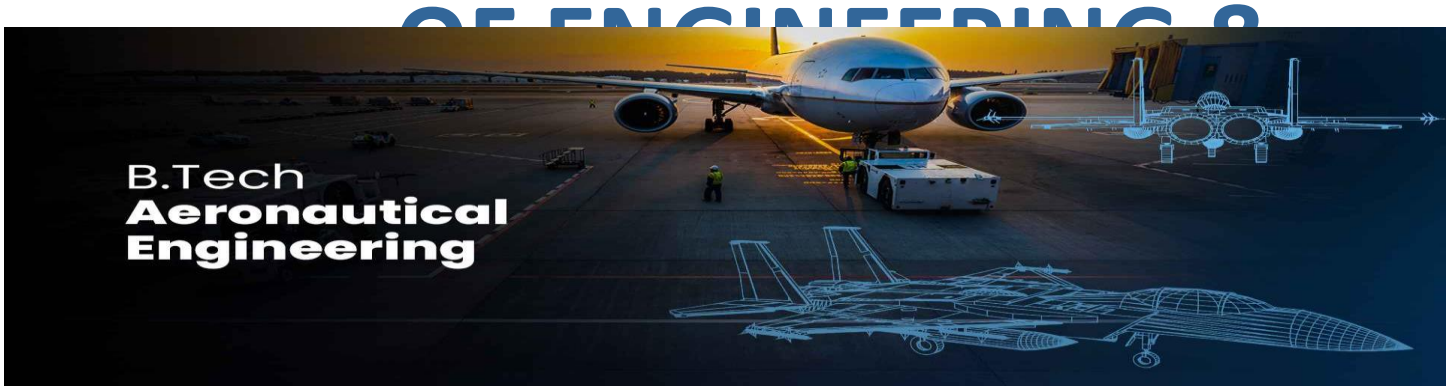
MRCET CAMPUS

MALLA REDDY COLLEGE

(AUTONOMOUS INSTITUTION – UGC, GOVT. OF INDIA)



Department of AERONAUTICAL ENGINEERING

AERODYNAMICS

QUESTION BANK

Prepared by:

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Department of ANE

Code No: **R15A2104** **R15**

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

II B.Tech II Semester Supplementary Examinations, February 2021

Aerodynamics

(AE)

Roll No										

Time: 2 hours 30 min **Max. Marks: 75**

Answer Any **Five** Questions

All Questions carries equal marks.

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1	Discuss how do you measure the pressure by using manometers and mechanical gauges?	**[15M]**
2	Derive the momentum equation in partial differential form.	**[15M]**
3	Derive the equation for non-lifting flow over circular cylinder and plot the variation of pressure over the cylinder.	**[15M]**
4	Derive the velocity potential function for source and sink flows.	**[15M]**
5	Derive an expression for von Karman momentum integral equation, representing the momentum balance across the thickness of the boundary layer.	**[15M]**
6	Sketch the boundary layer profile over a flat plate and explain all the regions over it.	**[15M]**
7	Derive the fundamental equation of thin airfoil theory.	**[15M]**
8	Describe briefly the design philosophies used in conventional high lift airfoil design.	**[15M]**

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R17

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1	Derive the continuity equation in both differential with an appropriate fluid flow model and explain the physical significance of each term in it.	**[14M]**
2	Explain the variation of pressure distribution over an airfoil with respect to angle of attack (negative to positive).	**[14M]**
3	a) Write the governing equations for an incompressible inviscid flow. b) What are the various elementary flows possible? c) What is Kutta condition? Explain.	**[4M]**
4	Using Thin airfoil theory, derive the expressions for calculating the aerodynamic center and Center of pressure for a symmetric airfoil.	**[14M]**
5	Explain the following: a) Vortex filament b) Helmholtz's vortex theorem	**[14M]**
6	An aeroplane weighing 100 kN has a span of 19.5 m and a wing-loading of 1.925 kN/m . The wings are rather sharply tapered having around the centre of span a circulation 10% greater than that for elliptic wings of the same span and lift. Determine the downwash angle one-quarter of the span behind the centre of pressure, which is located at the quarter-chord point. The air speed is 67 m/s. Assume the trailing vorticity to be completely rolled up just behind the wings.	**[14M]**
7	Explain the working principle and applications of spoilers and air brakes.	**[14M]**

8 Explain the working of low speed subsonic wind tunnel (closed circuit) with neat schematic diagram. **[14M]**

Code No: R18A2107 **R18**

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Aerodynamics

(AE)

Roll No										

Time: 2 hours 30 min **Max. Marks: 70**

Answer Any **Five** Questions

All Questions carries equal marks.

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1 Derive the momentum equation in differential form with an appropriate fluid flow model. **[14M]**

2 a) Classify the flow regimes based on Mach number. **[14M]**
b) Sketch the aerodynamic force and moments on a typical aircraft.
c) Define Center of pressure and Aerodynamic Center.

3 Explain the following: **[14M]**
a) Magnus Effect
b) D'Alembert's Paradox
c) Kutta - Joukowsky theorem

4 Derive the potential equation for a lifting flow over a circular cylinder. **[14M]**

5 Explain Prandtl's Lifting line theorem and derive the fundamental equation of Prandtl's lifting line theory. **[14M]**

6 An aeroplane weighing 73.6 kN has elliptic wings 15.23 m in span. For a speed of 90 m/s in straight and level flight at low altitude find (a) the induced drag; (b) the circulation around sections halfway along the wings. **[14M]**

7 What are the different drag reduction methods? Explain. **[14M]**

8 Explain the working of low speed subsonic wind tunnel (open circuit) with neat schematic diagram. **[14M]**

R17

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MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

II B.Tech II Semester Supplementary Examinations, July 2021

Aerodynamics

(AE)

Roll No										

Time: 3 hours
Max. Marks: 70

Answer Any **Five** Questions

All Questions carries equal marks.

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1 (a)	Define Airfoil. Explain the Nomenclature of Airfoil with a neat sketch.	**[7M]**
1(b)	Explain about different NACA airfoil series	**[7M]**
2(a)	With the help of pressure distribution diagram explain how lift is generated over an airfoil	**[7M]**
2(b)	Write about different types of drags that act when a body is in motion.	**[7M]**
3	Define Source and Sink flow with neat diagrams. Derive the expression of volume flow rate from a line source.	**[14M]**
4	Consider source of strength 'Λ' located at the origin. Superimpose on the flow a uniform flow with velocity V_∞ moving from left to right. This combination results in flow	**[14M]**

over a semi-infinite body. a) Find out the coordinates for location of stagnation point. b) What is the equation of streamline passing though the stagnation point?

5	A flat plate of length 0.8 m and width 1.9 m is kept in a sea level air stream flowing at a velocity of 5.3 m/s. Assuming a linear velocity profile for the boundary layer over the plate. Evaluate the boundary layer thickness at the end of the plate and total skin friction drag on the plate.	**[14M]**
6	Write short notes on (i) Boundary layer thickness ii) Displacement thickness (iii)Momentum thickness	**[14M]**
7	Derive the fundamental equation of Prandtl's lifting-line theory.	**[14M]**
8(a)	List the various high-lift devices for aerofoils.	**[7M]**
8(b)	What are secondary flows? Explain the formation of wing-fuselage trailing vortex.	**[7M]**

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R18

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

II B.Tech II Semester Regular/Supplementary Examinations, July 2021

Aerodynamics

(AE)

Roll No										

Time: 3 hours **Max. Marks: 70**

Answer Any **Five** Questions

All Questions carries equal marks.

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1	Derive the energy equation in differential form by applying the first law of thermodynamics to a fluid flow.	**[14M]**
2	Derive the continuity equation in differential form by using the physical principle of the conservation of the mass to a finite control volume fixed in space.	**[14M]**
3	Show that a source flow is a physically possible incompressible flow everywhere except at the origin. Also show that it is irrotational everywhere.	**[14M]**
4	Explain in detail how combination of uniform flow, doublet flow and vortex flow produces lifting flow over a cylinder with the help of neat sketches.	**[14M]**
5	Prove that downwash is constant over the span for an elliptical lift distribution.	**[14M]**
6	Derive the fundamental equation of Prandtl's lifting line theory?	**[14M]**

7 Describe about the slotted flaps & discuss the effects on the maximum lift coefficient on some variations of the slot like double slot and triple slot. **[14M]**

8 i. Differentiate between Open circuit and Closed-Circuit wind tunnels **[14M]**
ii. Can Computational Fluid Dynamics Tools replace the wind tunnel testing? Justify.

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Code No: R15A2104 **R15**

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

II B.Tech II Semester Supplementary Examinations, February 2022

Aerodynamics

(AE)

Roll No										

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B

Part A is compulsory which carriers 25 marks and Answer all questions.

Part B Consists of 5 SECTIONS (One SECTION for each UNIT). Answer FIVE Questions, Choosing ONE Question From each SECTION and each Question carries 10 marks.

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PART-A (25 Marks)

1). a efine center of pressure and write down the expression for center of pressure. **[2M]**

b xplain the difference between the low angle of incidence and high angle of incidence in the generation of lift of a cambered airfoil. **[3M]**

c onsider an airfoil in a flow with a freestream velocity of 150 m/s. The velocity at a given point on the airfoil is 170 m/s. Calculate the pressure coefficient at this point. **[2M]**

d btain an expression for velocity potential function for uniform flow. **[3M]**

e. Differentiate between thermal boundary layer thickness and velocity boundary layer thickness. **[2M]**

f. Draw the boundary layer profile for the subsonic viscous flow over a flat plate and name it. **[3M]**

g. Write Biot-Savart law. **[2M]**

h. Differentiate between starting, bound and trailing vortices of wings. **[3M]**

i. Briefly explain any two high lift configurations used to increase the lift of an airfoil. **[2M]**

j. What are multi-element airfoils? What are the five primary effects in the design of multi-element airfoils? **[3M]**

PART-B (50 MARKS)

SECTION-I

2 Derive energy equation in differential form. **[10M]**

OR

3 Obtain expressions for aerodynamic forces and moments for a two-dimensional airfoil. **[10M]**

SECTION-II

4 What is Kutta-Joukowski theorem? Obtain an expression for lift for a lifting flow over a circular cylinder. **[10M]**

OR

5 Show that the local jump in tangential velocity across the vortex sheet is equal to the local sheet strength. **[10M]**

SECTION-III

6 Obtain Blasius equation for incompressible inviscid flow over a flat plate at zero angle of attack. **[10M]**

OR

7 Explain the complete physics of the flow over a flat plate with neat sketches. Write down the factors influencing the boundary layer separation. **[10M]**

SECTION-IV

8 Derive the fundamental equation of Prandtl's lifting line theory. **[10M]**

OR

9 Write a short note **[5M]**

a) Induced drag **[5M]**
b) Elliptic lift distribution

SECTION-V

10 Write short notes on **[5M]**

a) Vortex generators and flaps in lift augmentation **[5M]**
b) Drag reduction

OR

11 Write short notes on **[5M]**

a) Multiple lifting surfaces **[5M]**
b) Effect of Slats and winglets on lift augmentation

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II B.Tech II Semester Supplementary Examinations, February 2022

Aerodynamics

(AE)

Roll No										

Time: 3 hours **Max. Marks: 70**

Note: This question paper Consists of 5 Sections. Answer **FIVE** Questions, Choosing ONE Question from each SECTION and each Question carries 14 marks

SECTION-I

1(a) xplain the flow characteristics of symmetrical and unsymmetrical airfoils with a neat schematic of lift–coefficient variation with angle of attack. **[7M]**

1(b) efine lift force, drag force, normal force and axial force acting on an airfoil? Develop the relation between these force components. **[7M]**

OR

2 r the NACA 2412 airfoil, the lift coefficient and moment coefficient about the quarter chord at -6^o angle of attack are -0.39 and -0.045, respectively. At 4^o angle of attack, these coefficients are 0.65 and -0.037, respectively. Calculate the location of aerodynamic center. **[14M]**

SECTION-II

3 erive the fundamental equation of thin aerofoil theory. **[14M]**

OR

4	Consider a thin flat plate at 5 deg. angle of attack. Calculate the a) lift coefficient b) moment coefficient about the leading edge, c) moment coefficient about the trailing edge.	**[14M]**

SECTION-III

5	Explain Boundary layer separation and methods to control it.	**[14M]**

OR

6	Consider linear velocity profile for the boundary layer over the plate, Develop the expressions for boundary layer thickness and the variation of wall shear stress with distance along the flat plate	**[14M]**

SECTION-IV

7(a)	Derive the relation for velocity induced at a point by an infinite straight vortex filament using Biot-Savart law.	**[7M]**
7(b)	Write a short notes on (a) Downwash b) Induced drag c) Induced angle of attack	**[7M]**

OR

8(a)	Explain the mechanism of formation of trailing vortices at wing tips of finite wings.	**[7M]**
8(b)	Explain the concept of winglet to reduce induced drag with neat sketch	**[7M]**

SECTION-V

9(a)	List the aerofoil design requirements and parameters for generating high co-efficient of lift.	**[7M]**
9(b)	Explain the boundary layer development over any multi surface airfoil.	**[7M]**

OR

10(a)	Discuss the methods to control the circulation over the airfoil.	**[7M]**
10(b)	Draw the Schematic of streamlines of flow over wave element crest and trough. Explain the flow phenomenon.	**[7M]**

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R18

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Aerodynamics

(AE)

Roll No										

Time: 3 hours **Max. Marks: 70**

Note: This question paper Consists of 5 Sections. Answer **FIVE** Questions, Choosing ONE Question from each SECTION and each Question carries 14 marks.

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SECTION-I

1 Obtain the expression for the aerodynamic force and moment coefficients by integrating the pressure and skin friction coefficients over the wing surface. **[14M]**

OR

2 Derive the Navier-Stokes equations by applying the physical principle of momentum. **[14M]**

SECTION-II

3 Prove that the theoretical result of lift coefficient is directly proportional to the angle of attack. **[14M]**

OR

4 i. Discuss about the Kelvin circulation theorem. **[7M]**

ii. Considering the non-lifting flow over a circular cylinder, Derive an expression for the pressure coefficient at an arbitrary point (r, θ) in this flow, and show that it reduces to $C_p = 1-4\sin^2\theta$ on the surface of the cylinder. **[7M]**

SECTION-III

5 i. Consider a finite wing with an aspect ratio of 6. Assume an elliptical lift distribution. The lift slope for the airfoil section is 0.1/degree. Calculate **[7M]**

and compare the lift slopes for (a) a straight wing, and (b) a swept wing,

with a half-chord line sweep of 45 degrees.

ii. Use the numerical 5(i), except for a lower aspect ratio of 3. From a comparison of the results from these two problems, draw some conclusions about the effect of wing sweep on the lift slope, and how the magnitude of this effect is affected by aspect ratio. **[7M]**

OR

6 i. Explain how induced drag is produced by a lifting wing. **[7M]**

ii. Based on the lifting line theory show that the downwash is constant over the span for elliptic lift distribution. **[7M]**

SECTION-IV

7 i. Summarize the selection criteria of vortex generators. **[7M]**

ii. Outline your views on Large eddy break-up device influence on drag. **[7M]**

OR

8 i. Illustrate the effectives of the retractable leading-edge slat. **[7M]**

ii. Appraise the aerodynamic performance of the Co-flow jet wing. **[7M]**

SECTION-V

9 Explain the Concept of a Six-Component wind tunnel Balance with illustrations, and give the standards of force measurement. **[14M]**

OR

10 i. How Shadowgraph Technique work, Describe about the Working Principle of Shadowgraph Techniques. **[7M]**

ii. How Schlieren Technique work, Describe about the Working Principle of Schlieren Techniques. **[7M]**

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