Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Course: Aerodynamics II (ASEG311) **Semester: V**

Programme: B.Tech ASE and B.Tech ASE+AVE

Time: 03 hrs. **Max. Marks: 100**

Instructions: Assume missing data, if any, appropriately.
Use sketches to justify your answer wherever required.

SECTION A

S. No.		Marks	CO
Q 1	Explain the Joukowski hypothesis for circulation produced by an airfoil.	**04**	**CO2**
Q 2	A wing with an elliptical planform and an elliptical lift distribution has aspect ratio 6 and span of 14 m. The wing loading is 1000 N/m^2, when flying at a speed of 160 km/hr at sea level. Calculate the induced drag for this wing.	**04**	**CO3**
Q 3	Define Kelvin's Circulation theorem and starting vortex.	**04**	**CO2**
Q 4	What is induced Drag and explain the phenomena of Downwash over the aircraft wing.	**04**	**CO3**
Q 5	Beechcraft model 18 the twin jet transport aircraft, for this airplane the zero-lift angle of attack is -1.9 degree, the lift slope of the airfoil section is 0.1 per degree, the lift efficiency factor τ = 0.04, and the wing aspect ratio is 10. Airplane is cruising at a lift coefficient equal of 0.24. Calculate the angle of attack of airplane?	**04**	**CO3**

SECTION B

Q 6	Transform a circle of radius *a* with the centre in the *z*-plane located on the *x*-axis, to a straight line using Kutta−Joukowski transformation function: $\zeta = z + \frac{b^2}{z}$	**10**	**CO1**
Q 7	Derive the relation for lift coefficient and lift slope for a symmetrical airfoil based on classical thin airfoil theory.	**10**	**CO2**
Q 8	The measured lift slope for the NACA 23012 airfoil is 0.1080 degree^{-1}, and $\alpha_{L=0}$= -1.3 degree. Consider a finite wing using this airfoil, with AR=8 and taper ratio = 0.8. Assume that $\delta = \tau$. Calculate the lift and induced drag coefficients for this wing at	**10**	**CO3**

	geometric angle of attack = 7 degree. **OR** Explain how the finite wing lift curve slope differs from that of an airfoil. Thus, derive a relation between the lift curve slope of a finite wing and airfoil.		
Q 9	Explain Prandtl-Glauert Compressibility Correction. At a given point on the surface of an airfoil, the pressure coefficient is -0.3 at very low speeds. If the freestream Mach number is 0.6, calculate C_p at this point.	**10**	**CO4**
	SECTION-C		
Q 10	Explain the term conformal transformation. Apply the transformation formulae to transform a circle into a symmetrical airfoil. **OR** Derive the complex potential function (w) for the following flows: (i) Uniform flow (U) in the direction of negative Ox axis. (ii) Point vortex with circulation (K) at the origin. (iii) Doublet of strength μ, at the origin in the direction of positive Ox axis.	**20**	**CO1**
Q 11	Show that for small perturbations, the linearized pressure coefficient can be given by $Cp = \frac{-2\hat{u}}{V\infty}$ Where $\hat{u}$ is the perturbation in the x-component of the freestream velocity, and V_∞ is the freestream velocity.	**20**	**CO4**

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SECTION A

S. No.		Marks	CO
Q 1	Discuss the Kutta's condition for the magnitude and direction of velocity at the trailing of an aerofoil.	**04**	**CO2**
Q 2	A monoplane weighing 73575 N has elliptic wing of span 15 m. When it flies at 300 km/h at sea level, determine the circulation around a section halfway between the wing root and the wing tip.	**04**	**CO3**
Q 3	Consider an NACA 2412 airfoil with a 2 m chord in an airstream with a velocity of 50 m/s at standard sea level conditions. If lift per unit span is 1353 N, what is the angle of attack?	**04**	**CO2**
Q 4	What do you understand by downwash, induced velocity and induced drag?	**04**	**CO3**
Q 5	Define *wash in* and *wash out*. How can a wing be aerodynamically twisted?	**04**	**CO3**

SECTION B

Q 6	Transform a circle of radius a with the centre in the z-plane located on the x-axis, to an ellipse using Kutta−Joukowski transformation function: $\zeta = z + \frac{b^2}{z}$ Also, find an expression for fineness ratio of the transformed ellipse.	**10**	**CO1**
Q 7	What is classical thin airfoil theory? Obtain an expression for lift coefficient and lift curve slope for symmetrical airfoil. **OR** For NACA 2412, the lift coefficient and moment coefficient about quarter-chord at -6 degree angle of attack are -0.39 and -0.045 respectively. At 4 degree angle of attack, these co-efficient are 0.65 and -0.037 respectively. Calculate the location of aerodynamic center.	**10**	**CO2**
Q 8	Justify the concept vortex sheet and deduce the strength of vortex involved in the sheet.	**10**	**CO3**
Q 9	Define Critical Mach number. At a given point on the surface of an aerofoil, the	**10**	**CO4**

	pressure coefficient is -0.54 at very low speeds. Calculate the pressure coefficient at this point when the freestream Mach number is 0.58.		
SECTION-C			
Q 10	Explain Kutta-Zhukovsky transformation. Apply the transformation formulae to transform a circle into a cambered airfoil. **OR** Consider the complex function w a function of z, such that, $w = f(z) = f(x+iy) = w_1 + i\, w_2$ Where, w_1 and w_2 are the real and imaginary part of the complex function w. Prove that the complex function satisfies the Cauchy-Riemann relations, $\frac{\partial w_1}{\partial x} = \frac{\partial w_2}{\partial y}$ and $\frac{\partial w_1}{\partial y} = \frac{-\partial w_2}{\partial x}$	**20**	**CO1**
Q 11	Derive an expression for the linearized pressure coefficient in compressible subsonic flow with small perturbation velocities.	**20**	**CO4**