Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Course: Flight Mechanics-II (ASEG401) **Semester: VII**

Programme: B-Tech ASE,ASEA

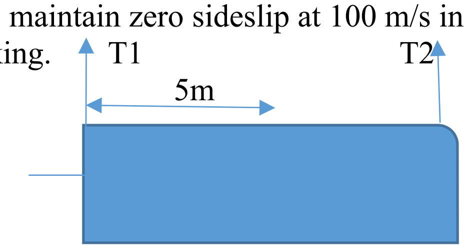
Time: 03 hrs. **Max. Marks: 100**

Instructions: Make use of *sketches/plots* to elaborate your answer. The Question Paper contain 3 Sections-Section A, B and C

SECTION A (5 x 4 = 20 Marks)

S. No.		**Marks**	**CO**
Q 1	How dihedral for low wing configuration contributes lateral stability of an aircraft. Derive it.	**5**	**CO3**
Q 2.	X-36 research aircraft does not have vertical stabilizers. Explain & derive it.	**5**	**CO3**
Q 3.	Center of pressure of an aircraft lies at a distance of 4.45m from its nose tip and center of gravity lies at 4.39 m. If the wing chord length is 1.00m. Determine static margin of the aircraft.	**5**	**CO1**
Q 4.	Define dorsal fin. How it contributes in providing directional stability.	**5**	**CO4**

SECTION B (10 x 4 = 40 Marks)

Q 5.	A twin jet engine has following data (Asymmetric power): Thrust of per engine = 10,000N Span wise distance between two engine= 10m Wing area=50m^2 Wing span=10m $Cn_{\delta r}$ = -0.001/degree Max rudder deflection= +- 20 degree Determine rudder deflection to maintain zero sideslip at 100 m/s in level flight at sea level with one engine not working.  	**10**	**CO3**
Q 6.	Consider the wing body model. The area and chord of the wing are 0.5m^2 and 0.2 m respectively. Assume horizontal tail is added to this model. the distance from the airplanes COG to the tail AC is 0.14 m, the tail area is 0.04m^2 , tail setting angle is 3.5^{0}the tail lift slope is 0.1 per degree ,ϵ_0 =0 and d€/dα =0.35 , a =0.08 , h – h $_{acwb}$	**10**	**CO4**

	=0.12 ,C $m_{,cg}$ = -0.024 . if α =12^0. (a) calculate $Cm_{,cg}$ for the airplane model. b) Does this model have longitudinal static stability and balance? If a=0.08 , , h – h_{acwb} =0.11, VH =0.34 , at =0.1per degree, d€/dα =0.35,C $m_{,acwb}$ = -0.032 ,$€_0$ =0,tail setting angle is 3.7^0		
Q 7.	a) Differentiate stick fixed and stick free longitudinal stability with necessary diagram. b) If the slope of Cm Verses CL curve is -0.10, C.G is located at 0.36 and the pitching moment at zero lift is equal to 0.08, determine a) trim lift coefficient b) stick fixed neutral point.	**10**	**CO2**
Q 8.	Derive second order differential equation for over damped motion, un-damped motion along with displacement Vs time plot of individual motions. OR Derive second order differential equation for critically damped motion with displacement Vs time plot. b) The differential equations for constrained center of gravity pitching motion of an airplane is computed to be $\ddot{\alpha} + 4\dot{\alpha} + 36\alpha = 0$ Find the following:- A) ζ damping ratio B) ω_d damped natural frequency rad/s C) ω_n natural frequency, rad/s	**10**	**CO1**
SECTION-C (20 x 2 = 40 Marks)			
Q 9.	An aircraft is ready for take-off when it is detected that a cross-wind of 8m/s is blowing across the runway .Determine the rudder angle required to maintain steady normal heading along the runway at unstick point using the following data. Wing loading= 2500N/m^2 Span= 25m Wing area= 70m^2 Unstick velocity=1.2 V_{stall}	**20**	**CO3**

	C_{Lmax}= 1.8 Lift-curve slope of vertical tail= 0.08/deg Cn_{β} = 0.012/deg Vertical tail volume ratio= 0.25 η =0.9 Assume that 1 deg of rudder deflection changes the vertical tail incident by 0.4 degree.		
Q10.	Derive Six degree of freedom rigid body force and moment Equations in body frame of references. Explain body and Inertial axes system & derive Euler rates in terms of the body angular velocities. OR a. Derive frequency and damping ratio for long- period and short-period motions. b. Define Terminology:- Spiral divergence, dutch roll, directional divergence, Phugoid motion & short period motion. c. Determine ω_n , ζ for short period and phugoid approximations if following data is given : X_u = $-0.045 s^{-1}$, X_w= $0.036 s^{-1}$ $X\dot{w}$ =0 Z_u =$-0.369 s^{-1}$ Z_w= $-2.02 s^{-1}$ $Z\dot{w}$ =0 M_u=0 M_w= -0.05 $M\dot{w}$= -0.0651 X_q =0 Z_q=0 M_q= $-2.05 s^{-1}$ U_0 =176ft/s	**20**	**CO2**

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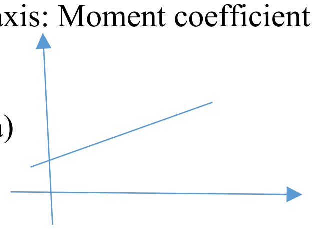
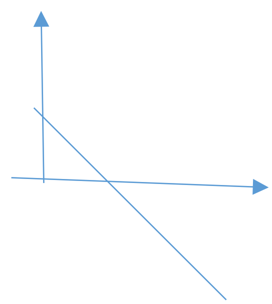
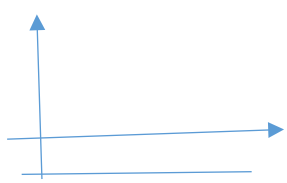
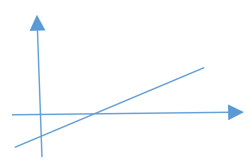
SECTION A (5 x 4 = 20 Marks)

S. No.		**Marks**	**CO**
Q 1	Vertical tail is placed beneath the fuselage then explain directional stability criterion.	**5**	**CO1**
Q 2.	Which of the following represents a graph of $C_{M,\, ac}$ (X-axis : Angle of attack,α ; Y-axis: Moment coefficient about ac, $C_{M,\, ac}$. a)  b)  c)  d)  Calculate $C_{m,\alpha}$ if aircraft is disturbed by a gust which increases the angle of attack by 2^0 . As a result a nose down pitching moment coefficient is 0.032 is produced about c.g of an aircraft.	**5**	**CO3**
Q 3.	Center of pressure of an aircraft lies at a distance of 4.47m from its nose tip and center of gravity lies at 4.37 m. If the wing chord length is 1.00m. Determine static margin of the aircraft.	**5**	**CO3**
Q 4.	Explain following Terminology:- a) Adverse Yaw Effect b) Control in crosswind take-off and landing with necessary sketches.	**5**	**CO4**

SECTION B (10 x 4 = 40 Marks)

Q 5.	a) Differentiate stick fixed and stick free longitudinal stability with necessary diagram.	**10**	**CO3**

	b) If the slope of Cm Verses CL curve is -0.10, C.G is located at 0.34 and the pitching moment at zero lift is equal to 0.07, determine a) trim lift coefficient b) stick fixed neutral point.		
Q 6.	A twin jet engine has following data (Asymmetric power): Thrust of per engine = 10,000N Span wise distance between two engine= 10m Wing area=50m^2 Wing span=10m $Cn_{\delta r}$ = -0.001/degree Max rudder deflection= +- 20 degree Determine rudder deflection to maintain zero sideslip at 100 m/s in level flight at sea level with one engine not working. T1 T2 5m 	**10**	**CO1**
Q 7.	Consider the full size airplane model. The airplane has wing area 19m/s2, weight of 22700N and elevator control effectiveness of 0.04 .Calculator elevator deflection angle necessary to trim the airplane at a velocity of 61 m/s at sea level if a=0.08 , Cm,o = 0.06 ,VH=0.34 , $dC_{m,cg} / d\alpha_a$ =-0.0133	**10**	**CO2**
Q 8.	a)Derive second order differential equation for over damped motion, un-damped motion along with displacement Vs time plot of individual motions. OR a)Derive second order differential equation for critically damped motion with displacement Vs time plot. b) The differential equations for constrained center of gravity pitching motion of an airplane is computed to be $\ddot{\alpha} + 4\dot{\alpha} + 36\alpha = 0$ Find the following:- a) ζ damping ratio b) ω_d damped natural frequency rad/s c) ω_n natural frequency, rad/s	**10**	**CO4**
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