KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year 2nd Term Examination, 2016

ME 4021

(Flight Dynamics)

Time: 3 Hours. Total Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION – A

1(a)	How did aeronautics past the limitation of birds?	07
1(b)	How flow separation causes a drastic loss of lift and a major increase of pressure drag over an aerofoil? Explain with appropriate diagrams.	12
1(c)	By applying the momentum equation to a control volume surrounding an aerofoil, prove that drag force on the aerofoil is equal to the decrease of momentum of the flow.	16
2(a)	Why raders and spoilers are used in an airplane?	07
2(b)	What is downwash and what are the consequences of downwash? Write down the physical interpretations of how downwash create induced drag in wing?	10
2(c)	With necessary diagram show the six motion of an airplane in flight? What are the control surfaces used to control these motions? Explain with functions of these surfaces with neat sketch.	18
3(a)	What is meant by high lift devices? Give examples. Explain with appropriate diagrams how flaps increase lift coefficient?	12
3(b)	Explain why pressure is low on upper surface of an airfoil than lower surface? Use fundamental principle of mass conservation and Newton's second law to explain your answer.	08
3(c)	Define the aerodynamic center of the wing. Explain why aerodynamic center is a useful concept for the stability and control? Write the criteria for longitudinal static stability of an aircraft.	15
4(a)	Derive the expression of $C_{M,cgt} = -a_t v_H \alpha_{wb}\left(1 - \frac{\partial t}{\partial \alpha}\right) + a_t v_H(\varepsilon_o + i_t)$, where symbols have their usual meanings.	18
4(b)	An aircraft is in level flight at 225 Km/hr through air at standard condition. The lift and drag coefficients at this speed are 0.45 and 0.065 respectively. The mass of the aircraft is 900 kg. Calculate the effective lift area of the craft, thrust and power required of the engine.	17

SECTION - B

5(a)	What is meant by ground effect and why it should be accounted while take-off ?	06
5(b)	Drive the expression of landing ground roll distance for an airplane. Discuss the ways by which the landing ground roll distance can be deduced.	17
5(c)	Define load factor and wing loading. Explain the practical constraints that limit maximum load factor using V-n diagram.	12
6(a)	Explain why modern airplane requires horizontal tail for longitudinal stability? Explain with diagrams.	15
6(b)	Derive the expression for contribution of the wing to M_g.	15
6(c)	How stability can be achieved by maintaining neutral point?	05

7(a) Describe the mechanism of thrust production in two alternate explanations and use the explanations to drive the fundamental thrust equation for et engines. 18

7(b) Why afterburner is used in a turbojet engine? Explain the working principle of a ramjet engine. 17

8(a) What is meant by detonation? Classify the detonation engines. Write down the advantages and applications of pulse detonation engine 10

8(b) Briefly explain the fundamentals of rotating detonation engine (RDE). 10

8(c) A rocket engine burning hydrogen and oxygen; the combustion chamber pressure and temperature are 25 atm and 3517K, respectively. The area of the rocket nozzle throat is 0.1 m^2. The area of the exit is designed, so that the exit pressure exactly equals ambient pressure at a standard altitude of 30 Km. For the gas mixture, γ=1.22 and molecular weight $\overline{M}$=16. Calculate; 15

(i) Specific impulse
(ii) Area of the exit

Assume $\bar{R} = 8314\, j/Kg\, mol.K$.