

Hall Ticket No

Question Paper Code: AAE014



# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

## MODEL QUESTION PAPER

Third Year B.Tech VI Semester End Examinations, April / May – 2019

Regulations: IARE - R16

### AIRCRAFT STABILITY AND CONTROL

(AERONAUTICAL ENGINEERING)

Time: 3 hours

Max. Marks: 70

Answer ONE Question from each Unit

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

#### UNIT – I

1. a) What are the two methods for predicting fuselage contribution to longitudinal stability of airplane? Write down the formulae for simpler method and explain the terms in it. [7M]
- b) With neat diagram explain the effect of elevator on longitudinal static stability. Draw the flow pattern with and without elevator deflection on total airplane. [7M]
2. a) Explain the method to measure stick fixed neutral point during flight. Draw the respective plots and explain. [7M]
- b) Derive expression for elevator trim condition and explain all parameter obtained in trim equation. [7M]

#### UNIT – II

3. a) During flight, it was observed that rudder got fixed 3 degree right. How the pilot will handle this condition? Show with diagram. [7M]
- b) With neat diagram explain about static roll stability. Show the attitude of airplane in different stability conditions. [7M]
4. a) How the total directional stability contribution of parts of airplane is made more stabilizing? [7M]
- b) Explain the contribution of wing and fuselage in airplane directional stability. [7M]

#### UNIT – III

5. a) Express all forces (weight, aerodynamic, and thrust) for sea level at military thrust in most convenient axis system. Assume the thrust lines are parallel to the longitudinal axis and in plane of CG. The aircraft weighs 24.5 kN and each engine is delivering 3.11kN thrust. [7M]
- b) What are the equations of longitudinal motion with free control? [7M]

6. a) How Earth Axis to Body Axis transformation takes place? Show Euler's angles and explain. [7M]  
b) Explain about types of moments of inertia applicable in equations of motion. Give their mathematical formula. [7M]

#### UNIT – IV

7. a) Explain the significance of aerodynamic derivatives on airplane stability. [7M]  
b) What do you understand by lateral static stability derivative? Write the formula and explain its importance. [7M]
8. a) Explain roll helix angle. Show the wing velocity distribution due to roll rate. [7M]  
b) Derive the expression for cross derivative  $C_{np}$  and explain each term. [7M]

#### UNIT – V

9. a) What are the two distinct types of longitudinal modes required describing the Motion of an aircraft, when the aircraft is not perturbed about the roll or yawing axis? Explain them in detail. [7M]  
b) Sketch a single parameter stability diagram or a root locus plot when  $C_{m\alpha}$  changes from a large negative value to a small positive value. [7M]
10. a) Explain the term degrees of freedom. How many degrees of freedom does a rigid airplane with free aileron, elevator and rudder have? [7M]  
b) Explain Aircraft Dynamic Mode shapes and their significance. [7M]



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## COURSE OBJECTIVES (COs):

The course should enable the students to:

I	Demonstrate concept of stability and application to dynamic systems like Aircraft, and the role of primary controls and secondary controls in longitudinal stability.
II	Learn about the mathematical modeling of an aircraft in longitudinal, lateral and directional cases.
III	Estimate the longitudinal and directional parameters with the help of the linearized equations of aircraft motion.
IV	Analyze the different type of modes in longitudinal, lateral and directional motion of aircraft, and recovery from those modes.

## COURSE LEARNING OUTCOMES (CLOs)

Students, who complete the course, will be able to demonstrate the ability to do the following:

AAE014.01	Apply concept of stability, controllability and maneuverability in an aircraft.
AAE014.02	Use and interpret the basic mathematics, science and engineering for solving problems of longitudinal, lateral and directional static stability.
AAE014.03	Describe stick fixed and stick free conditions for neutral point.
AAE014.04	Demonstrate different methods for finding static margin, control force and CG limitation.
AAE014.05	Organize total stability parameters in order of merit of flight conditions.
AAE014.06	Locate the cause of instability in an aircraft and solve the issue.
AAE014.07	Identify aircraft different types of stability for different categories of aircraft.
AAE014.08	Demonstrate the aircraft component contribution for different stability.
AAE014.09	Discuss and identify the stability problems of aircraft in different phases.
AAE014.10	Relate different stability criteria and do the comparative study.
AAE014.11	Interpret the concept behind equations of motions in different frame of references.
AAE014.12	Appraise the factors that enhance the stability of aircraft during different flight regime.
AAE014.13	Create new concept of the stability in new configuration and type of aircrafts.
AAE014.14	Describe the effects of forces and moments in disturbed or perturbed conditions on the stability.
AAE014.15	Discuss the concept of linearization of equation of motion and aerodynamic forces and moments.

## MAPPING OF SEMESTER END EXAMINATION TO COURSE OUTCOMES

SEE Question No.		Course Outcomes		Bloom's Taxonomy Level
1	a	AAE014.03	Describe stick fixed and stick free conditions for neutral point.	Remember
	b	AAE014.03	Describe stick fixed and stick free conditions for neutral point.	Understand
2	a	AAE014.02	Use and interpret the basic mathematics, science and engineering for solving problems of longitudinal, lateral and directional static stability.	Remember
	b	AAE014.02	Use and interpret the basic mathematics, science and engineering for solving problems of longitudinal, lateral and directional static stability.	Understand
3	a	AAE014.04	Demonstrate different methods for finding static margin, control force and CG limitation.	Understand
	b	AAE014.06	Locate the cause of instability in an aircraft and solve the issue.	Understand
4	a	AAE014.06	Locate the cause of instability in an aircraft and solve the issue.	Understand
	b	AAE014.05	Organize total stability parameters in order of merit of flight conditions.	Understand
5	a	AAE014.08	Demonstrate the aircraft component contribution for different stability.	Remember
	b	AAE014.09	Discuss and identify the stability problems of aircraft in different phases.	Remember
6	a	AAE014.08	Demonstrate the aircraft component contribution for different stability.	Remember
	b	AAE014.05	Organize total stability parameters in order of merit of flight conditions.	Remember
7	a	AAE014.10	Relate different stability criteria and do the comparative study.	Remember
	b	AAE014.13	Create new concept of the stability in new configuration and type of aircrafts.	Understand
8	a	AAE014.10	Relate different stability criteria and do the comparative study.	Understand
	b	AAE014.11	Interpret the concept behind equations of motions in different frame of references.	Understand
9	a	AAE014.15	Discuss the concept of linearization of equation of motion and aerodynamic forces and moments.	Remember
	b	AAE014.14	Describe the effects of forces and moments in disturbed or perturbed conditions on the stability.	Remember
10	a	AAE014.13	Create new concept of the stability in new configuration and type of aircrafts.	Remember
	b	AAE014.14	Describe the effects of forces and moments in disturbed or perturbed conditions on the stability.	Understand

Signature of Course Coordinator

HOD, AE