INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**FLIGHT CONTROL THEORY**				
Course Code	AAE018				
Program	B.Tech				
Semester	VIII	AE			
Course Type	core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	-
Chief Coordinator	Mr. P Anudeep, Assistant Professor				
Course Faculty	Mr. P Anudeep, Assistant Professor				

COURSE OBJECTIVES:

The course should enable the students to:	
I	Apply stability criteria to determine the stability of an aircraft, and specify the aircraft time-domain and frequency-domain response specifications.
II	Understand Classical control theory in the frequency domain and modern control theory in the state- space are effectively mixed to provide the student with a modern view of systems theory.
III	Design control techniques for aircraft control systems, and study some feedback control applications.
IV	Study the controllability and observability of aerospace systems, and apply the modern control techniques to design enhanced flight control systems.

COURSE OUTCOMES (COs):

CO 1	Describe the analysis techniques for classical control theory to nonlinear system
CO 2	To describe and analyze the physical system with inherent non-linearity for stability and performance.
CO 3	Provide knowledge on various adaptive schemes, with a basic understanding on closed loop system stability and implementation issues
CO 4	Describe the principle of approximations to aircraft transfer functions, control surface actuators-review. response of aircraft to elevator input, response of aircraft to rudder input and response of aircraft to aileron input to atmosphere
CO 5	Define reversible and irreversible flight control systems. flying qualities of aircraft-relation to airframe transfer function. pilot's opinion ratings. flying quality requirements- pole-zero, frequency response and time- response specifications.

COURSE LEARNING OUTCOMES (CLOs):

AAE018.01	Define the basic concepts associated with Control Theory and its application.
AAE018.02	Review Fourier Transform with mathematical operations and its applications.
AAE018.03	Review Laplace Transform and some other important mathematical operations.
AAE018.04	Understand about the concepts of Transfer function, its merits and applications.
AAE018.05	Understand the control system performance with the time domain description.
AAE018.06	Analyze the steady state response and application of feedback in augmentation controls.
AAE018.07	Understand the control system performance with the frequency domain description.
AAE018.08	Analyze an aircraft’s performance to controls and related aspects.
AAE018.09	Evaluate an aircraft’s performance from the control point of view as a system.
AAE018.10	Determine the Approximations to aircraft transfer functions.
AAE018.11	Understand about stability augmentation systems for an aircraft with autopilot system.
AAE018.12	Determine the Flying qualities of aircraft and requirements.
AAE018.13	Understand about the concepts of feedback control its merits and applications.
AAE018.14	Understand the concept of control surface actuators and its usage in aircraft applications.
AAE018.15	Determine the Displacement and rate feedback determination of gains conflict with pilot inputs resolution

TUTORIAL QUESTION BANK

UNIT -I				
INTRODUCTION TO CONTROL SYSTEMS				
Part - A (Short Answer Questions)				
S No	**QUESTIONS**	**Blooms taxonomy level**	**Course Outcomes**	**Course Learning Outcomes**
1	List the components of a control System?	Remember	CO 1	AAE018:01
2	Define the terms plant and Process	Understand	CO 1	AAE018:01
3	State the advantages and drawbacks of open loop control system?	Understand	CO 1	AAE018:01
4	Define linear time invariant system.	Understand	CO 1	AAE018:01
5	List the properties of robust system.	Remember	CO 1	AAE018:01
6	State two examples of control system?	Understand	CO 1	AAE018:01
7	Define dynamical systems and list its components.	Remember	CO 1	AAE018:01
8	Define the feedback control systems and List the types of feedback control systems?	Remember	CO 1	AAE018:01
9	What are the effects of feedback on stability of control system?	Understand	CO 1	AAE018:01
10	Differentiate between System & Control System?	Remember	CO 1	AAE018:02
Part - B (Long Answer Questions)				
1	Discuss sensor and list sensors used in aircraft control systems?	Understand	CO 1	AAE018:01
2	Differentiate between open and closed loop control system?	Understand	CO 1	AAE018:01
3	List out the merits and demerits of nonlinear system.	Understand	CO 1	AAE018:01
4	Discuss the importance of studying control system?	Remember	CO 1	AAE018:01
5	Explain the function of control as regulation and tracking.	Understand	CO 1	AAE018:01
6	Discuss sensitivity of output to control input in a feedback control system?	Remember	CO 1	AAE018:01
7	List the merits of open loop system and Discuss the need for a stable System.	Understand	CO 1	AAE018:01
8	Discuss the application of feedback control in control augmentation system and automatic systems?	Remember	CO 1	AAE018:01
9	Discuss the rules and conventions of reducing the block diagram of Complex systems?	Understand	CO 1	AAE018:01
10	List the advantages & disadvantages of positive feedback control systems?	Remember	CO 1	AAE018:01
Part - C (Problem Solving And Critical Thinking Questions)				
1	Discuss the purpose and functioning of various filters used in control Systems and how is overall system stability determined?	Understand	CO 1	AAE018:02
2	Describe a SISO Single input single output) system and a MIMO (Multiple input and multiple output) system and explain how they are analyzed.	Remember	CO 1	AAE018:01
3	Describe non linear system and discuss how they are linearized?	Understand	CO 1	AAE018:01
4	Explain the role of feedback in stability augmentation, control Augmentation and automatic control with example.	Remember	CO 1	AAE018:01

5	Discuss use of transducer, sensor and filter in control system.	Understand	CO 1	AAE018:01
6	With example explain the method of modeling dynamical systems using differential equations	Remember	CO 1	AAE018:02
7	Discuss modeling and transfer function of different filters used in aircraft control	Understand	CO 1	AAE018:01
8	Discuss application of feedback in stability augmentation system.	Remember	CO 1	AAE018:01
9	Functionally, how do closed-loop systems differ from open-loop system? Also give three examples of open loop systems.	Understand	CO 1	AAE018:02
10	Explain the procedure for analyzing SISO and MIMO system.	Understand	CO 1	AAE018:01
UNIT -II				
MATHEMATICAL MODELLING OF DYNAMIC SYSTEMS				
Part - A (Short Answer Questions)				
1	Define gain factor, pole and zero?	Remember	CO 2	AAE018:02
2	Define characteristic equation with example?	Remember	CO 2	AAE018:02
3	What do you understand by feedback gain?	Understand	CO 2	AAE018:03
4	Define Nyquist plot and Bode plots?	Remember	CO 2	AAE018:02
5	What do you understand by frequency domain?	Understand	CO 2	AAE018:03
6	What is the steady state and transient response specified?	Understand	CO 2	AAE018:03
7	Define open loop and closed loop control system with example?	Understand	CO 2	AAE018:02
8	What are the effects of feedback on stability of control system?	Remember	CO 2	AAE018:03
9	What do you mean by frequency transfer function?	Understand	CO 2	AAE018:02
10	Define Transfer function of control theory?	Remember	CO 2	AAE018:03
Part - B (Long Answer Questions)				
1	Give the expression for the rise time of the step response for second order systems with respect to first order systems?	Remember	CO 2	AAE018:02
2	Discuss the relationship between impulse response and transfer function with the suitable example.	Understand	CO 2	AAE018:02
3	With example discuss the time domain specifications of second order control system	Remember	CO 2	AAE018:03
4	Describe the inverse transforms- significance and its applications to differential equations.	Understand	CO 2	AAE018:02
5	Briefly discuss impulse response and indicial response in terms of time frequency performance.	Understand	CO 2	AAE018:03
6	Explain the difference between system parameters and characteristic Parameters of control systems.	Remember	CO 2	AAE018:04
7	What do you understand by gain margin and phase margin with respect to S domain?	Understand	CO 2	AAE018:02
8	Explain the methods of Frequency and damping ratio of dominant poles?	Remember	CO 2	AAE018:03
9	Explain in detail about the review of Fourier transforms and Laplace transforms.	Understand	CO 2	AAE018:02
10	Explain about the different types of transducers and sensors used in control system?	Remember	CO 2	AAE018:02
Part – C (Problem Solving and Critical Thinking)				
1	Discuss in detail about the first and second order linear systems	Remember	CO 2	AAE018:02
2	Discuss the significance of Partial fraction decomposition of transfer functions.	Remember	CO 2	AAE018:02
3	Discuss the significance of corner frequencies, resonant frequencies and peak gain of a second order system.	Understand	CO 2	AAE018:03
4	Explain the experimental method of determining system transfer function by frequency response measurements.	Remember	CO 2	AAE018:02
5	Find the poles and zeros of a control system whose transfer functions given by $G(s) = (s+3)/ (s^2+7s+12)$	Remember	CO 2	AAE018:03
6	A control system is defined by the following differential equation. Find the output response y (t) using Laplace transform method. Assuming y(t) and dy(t)/dt are zero at t = 0.	Understand	CO 2	AAE018:02

	$\frac{d^2y(t)}{dt^2} + 7\frac{dy(t)}{dt} + 12y(t) = u(t)$ where u (t) is unit step unit.			
7	Discuss the significance of band width, resonant frequencies, peak gain in relation to second order system.	Remember	CO 2	AAE018:03
8	Transfer function of a control system is s/((s+1)(s+2)). Find the response for the unit step input.	Understand	CO 2	AAE018:02
9	Explain the frequency response method of control system design.	Remember	CO 2	AAE018:02
10	Discuss the procedure of experimental determination of system transfer functions by frequency response measurements.	Understand	CO 2	AAE018:03
UNIT –III				
STEADY STATE RESPONSE ANALYSIS				
Part - A (Short Answer Questions)				
1	Define steady state error constants.	Understand	CO 3	AAE018:04
2	What is the need for comprise in control systems?	Understand	CO 3	AAE018:05
3	Define transient state with an example.	Understand	CO 3	AAE018:04
4	Write a short note on accuracy?	Understand	CO 3	AAE018:04
5	List the specifications in frequency response.	Understand	CO 3	AAE018:05
6	Define steady state with an example.	Remember	CO 3	AAE018:04
7	What is the scope of optimization?	Understand	CO 3	AAE018:05
8	Describe primacy of stability.	Remember	CO 3	AAE018:05
9	Define stability in terms of control systems	Understand	CO 3	AAE018:05
10	Write a short note on robustness?	Remember	CO 3	AAE018:02
11	Differentiate between fist order and second order systems.	Remember	CO 3	AAE018:06
12	What are requirements essential for control system performance?	Understand	CO 3	AAE018:06
13	Write a short note on speed of response?	Understand	CO 3	AAE018:06
14	List the specifications for steady state.	Remember	CO 3	AAE018:04
15	Describe the specifications for transient state?	Remember	CO 3	AAE018:06
16	Write a short note on second order systems.	Understand	CO 3	AAE018:04
17	List the specifications in time and frequency response.	Remember	CO 3	AAE018:04
18	How do errors occur in steady state?	Understand	CO 3	AAE018:06
19	List the specifications in s domain.	Remember	CO 3	AAE018:06
20	Write a short note on first order systems.	Understand	CO 3	AAE018:04
Part – B (Long Answer Questions)				
1	List the requirements for control system performance and its synthesis	Remember	CO 3	AAE018:04
2	Discuss steady state and transient specifications of a second order system and first order system.	Understand	CO 3	AAE018:02
3	Differentiate between transient state and steady state with suitable examples and its necessity.	Remember	CO 3	AAE018:04
4	List the examples of first order systems with the help of transient state equation and explain it.	Understand	CO 3	AAE018:04
5	List the examples of second order system with the help of transient state equation and explain it.	Remember	CO 3	AAE018:04
6	List the specifications for Time, Frequency and S domain	Understand	CO 3	AAE018:02
7	How the desired input varies with the output and explains the relationship between them.	Understand	CO 3	AAE018:02
8	Explain steady state systems and list the specifications with suitable examples in control systems.	Remember	CO 3	AAE018:06
9	Explain the design of multi loop feedback systems.	Understand	CO 3	AAE018:04
10	Discuss the merits and demerits of proportional derivative controller.	Understand	CO 3	AAE018:06

11	Discuss Nyquist criterion and the usage of this criterion in the control system.	Understand	CO 3	AAE018:04
12	Give the general effects of phase-lead controller on rise and settling time to control the system.	Remember	CO 3	AAE018:06
Part – C (Problem Solving And Critical Thinking)				
1	Explain the control systems and its performance requirements with the suitable examples.	Remember	CO 3	AAE018:04
2	List the conflicting requirements for the control system which effects the control system process.	Understand	CO 3	AAE018:03
3	Discuss and differentiate between Time and frequency response and explain them with the neat sketch.	Remember	CO 3	AAE018:04
4	With the suitable examples Differentiate the first order system from second order system in control theory?	Understand	CO 3	AAE018:04
5	Discuss the errors in steady state and transient state of control systems which will happens due to stability.	Remember	CO 3	AAE018:04
6	How does the PD controller affect the bandwidth of a control system and which errors will occur?	Understand	CO 3	AAE018:05
7	Define and discuss the purpose of gain scheduling in the controller and its specifications to control the gain.	Understand	CO 3	AAE018:05
8	Discuss the type of controllers and explain them in detail	Understand	CO 3	AAE018:06
9	List the advantages and disadvantages of Block diagram Reduction technique	Remember	CO 3	AAE018:04
10	List the advantages of gain and phase margin with suitable examples	Understand	CO 3	AAE018:06
11	Discuss frequency response method of analysis and compensation in control system.	Remember	CO 3	AAE018:04
12	Discuss the significance and interpretation of gain margin, phase margin.	Understand	CO 3	AAE018:06
UNIT -IV				
AIRCRAFT RESPONSE TO CONTROLS				
Part – A (Short Answer Questions)				
1	List out the control surface actuators.	Understand	CO 4	AAE018:07
2	Define reversible flight control systems.	Remember	CO 4	AAE018:08
3	List the flying quality requirements.	Understand	CO 4	AAE018:09
4	Write a short note on Acceleration and Turn rate	Remember	CO 4	AAE018:08
5	List the frequency response specifications.	Understand	CO 4	AAE018:07
6	Explain the performance of control actuators.	Remember	CO 4	AAE018:07
7	Define Flight control system.	Understand	CO 4	AAE018:09
8	List the time response specifications.	Remember	CO 4	AAE018:10
9	State Zeigler and Nicholas method	Understand	CO 4	AAE018:07
10	Define robust control.	Understand	CO 4	AAE018:10
Part – B (Long Answer Questions)				
1	Discuss the need for automatic control in the aircraft in terms of flight control systems.	Understand	CO 4	AAE018:07
2	Explain the purpose of auto pilot by using the control systems with help of neat sketch.	Remember	CO 4	AAE018:10
3	Explain the role of rate feedback in stability augmentation system with the help of neat sketch and its importance.	Understand	CO 4	AAE018:10
4	Differentiate between reversible and irreversible control.	Remember	CO 4	AAE018:11
5	What do you mean by pilot's opinion rating in the flight control systems and explain it in detail?	Understand	CO 4	AAE018:07
6	Draw the block diagram of a pitch attitude hold auto-pilot system and explain it briefly.	Understand	CO 4	AAE018:07
7	What is the purpose of stability augmentation system and its importance in the control systems?	Remember	CO 4	AAE018:11

8	Bring out the purpose of feedback signals in autopilot system and differentiate it from flight control system.	Understand	CO 4	AAE018:12
9	Discus the relationship between flying qualities and aircraft transfer function.	Remember	CO 4	AAE018:07
10	Explain how a modern design technique helps in designing SAS (Stability Augmentation System) as well as autopilots	Understand	CO 4	AAE018:12
Part – C(Problem Solving And Critical Thinking)				
1	Discuss the flying qualities requirement of an aircraft. What is pilot's opinion rating? and explain the purpose and functioning of pitch, yaw and bank hold auto pilot.	Remember	CO 4	AAE018:07
2	Briefly explain the role of displacement and rate feedback in the design of stability augmentation system.	Understand	CO 4	AAE018:12
3	List the steps to determine the transfer function of an aircraft to perform the control operations	Remember	CO 4	AAE018:12
4	Explain the role of auto-pilot as stability augmenter.	Understand	CO 4	AAE018:11
5	Differentiate between stability control system and control augmentation system.	Understand	CO 4	AAE018:07
6	Discuss the response of an aircraft to pilot's control input and atmosphere	Remember	CO 4	AAE018:07
7	Discuss the functioning of normal acceleration command maneuvering autopilot.	Understand	CO 4	AAE018:11
8	Explain how approximate aircraft transfer function is obtained from control systems.	Understand	CO 4	AAE018:12
9	With help of block diagram explain the functioning and components of a displacement autopilot.	Remember	CO 4	AAE018:07
10	Briefly explain about the controls that control the Pitching moment and rolling moment in aircraft stability.	Understand	CO 4	AAE018:12
UNIT -V				
FLYING QUALITIES OF AIRCRAFT				
Part - A (Short Answer Questions)				
1	Discuss the limitation of classical control.	Remember	CO 5	AAE018:15
2	What is time invariant linear system?	Understand	CO 5	AAE018:14
3	Define matrix transfer function in control system.	Remember	CO 5	AAE018:13
4	Illustrate controllability in terms of stability.	Understand	CO 5	AAE018:12
5	Define canonical transformation of state equations.	Understand	CO 5	AAE018:14
6	Differentiate between controllability and observability	Understand	CO 5	AAE018:13
7	Write a short note on state variable and state equation.	Remember	CO 5	AAE018:13
8	List out the digital integration rules.	Understand	CO 5	AAE018:14
9	Define observability in terms of control theory	Remember	CO 5	AAE018:15
10	Write down the short note on multiple inputs multiple output systems?	Understand	CO 5	AAE018:08
Part - B (Long Answer Questions)				
1	Briefly explain the concept of reversible flight control systems with help of a neat diagram.	Remember	CO 5	AAE018:15
2	Write the advantages and disadvantages of digital control system over analog control system.	Understand	CO 5	AAE018:14
3	Differentiate between state variable and state equation in terms of modern control theory.	Remember	CO 5	AAE018:13
4	Discuss the process of numerical solution of state equation to solve the error occurs in control theory.	Understand	CO 5	AAE018:08
5	Explain about the concept of state space modeling of dynamical systems with the block diagram?	Understand	CO 5	AAE018:15
6	Draw the block diagram representation of a generic digital controller and explain it briefly.	Understand	CO 5	AAE018:13
7	List the limitations of classical methods of control system modeling and its specifications.	Remember	CO 5	AAE018:15
8	Briefly explain about State transition matrix and Matrix transfer function	Understand	CO 5	AAE018:10

9	List the properties for the numerical solution of state equations and state variables.	Remember	CO 5	AAE018:12
10	State the concept of Digital control in the modern control theory with help of neat sketch.	Understand	CO 5	AAE018:13
Part – C (Problem Solving And Critical Thinking)				
1	Discuss the method of modeling dynamical system using state space equations.	Remember	CO 5	AAE018:12
2	What is controllability? How do you test the controllability of a system in the modern control systems?	Understand	CO 5	AAE018:12
3	Define the state variable and state equations with examples. And Discuss the properties of state transition matrix.	Remember	CO 5	AAE018:13
4	Discuss limitation of classical control theory when applied to multiple input multiple output systems.	Understand	CO 5	AAE018:14
5	List the advantages and disadvantages of digital control systems with suitable examples.	Understand	CO 5	AAE018:12
6	Discuss the advantages of digital control system over analog control system and its usage.	Understand	CO 5	AAE018:13
7	Explain the multiple input multiple output systems with the block diagram and its applications.	Remember	CO 5	AAE018:13
8	Discuss state space modeling of dynamical system. And list the properties of state –transition matrix.	Understand	CO 5	AAE018:14
9	Discuss general form of time invariant linear system.	Remember	CO 5	AAE018:15
10	Discuss the significance of Canonical transformation of state equations to solve problems in modern control theory.	Understand	CO 5	AAE018:13

Prepared By: Mr. P Anudeep, Assistant Professor **HOD,AE**