

**COURSE TITLE** : CONTROL SYSTEMS & MATLAB  
**COURSE CODE** : 4060  
**COURSE CATEGORY:** A  
**PERIODS / WEEK** : 4  
**PERIODS / TERM** : 72  
**CREDITS** : 4

**TIME SCHEDULE**

MODULE	TOPIC	PERIODS
I	Transfer function	17
	Test I	1
II	Block diagram Algebra & Signal flow graph	17
	Test II	1
III	Stability Analysis	17
	Test III	1
IV	Introduction to MATLAB	17
	Test IV	1
<b>TOTAL</b>		<b>72</b>

**OBJECTIVES**

**MODULE I**

**1.1.0 Understand basic control system.**

- 1.1.1 State the meaning of physical systems, physical model and mathematical model.
- 1.1.2 Differentiate open loop and closed controls system.

**1.2.0 Understand the principle of Laplace transforms.**

- 1.2.1 Define Laplace transform.
- 1.2.2 Review of initial value and final value theorems.
- 1.2.3 Derive the Laplace transforms of test inputs step, ramp, parabolic, impulse inputs,

**1.3.0 Systems and Transfer Functions**

- 1.3.1 Define of transfer function, order of system. Transfer function of linear systems
- 1.3.2 Derive the transfer function of mechanical translational and rotational system
- 1.3.3 Derive the transfer functions of RLC series and parallel circuits
- 1.3.4 Discuss the elements of liquid level systems, pressure systems thermal systems.

**MODULE II**

**2.1.0 Know about Time response of a system I order with step, ramp, impulse inputs**

- 2.1.1 Understand the type of systems - Static error coefficients - Static position, velocity & acceleration error coefficient
- 2.1.2. Steady state error in terms of  $K_p$ ,  $K_v$ ,  $K_a$  for Type 0, Type 1 and Type 2 systems.

**2.2.0 Block Diagram algebra**

- 2.2.1 State the block diagram reduction rules.
- 2.2.2 Obtain the over all transfer function of control systems by block diagram reduction rules (single input-single output systems).

**2.3.0 Understand signal flow graph.**

- 2.3.1 Define the various parameters of the signal flow graph.
- 2.3.2 State and explain Mason's gain formula.
- 2.3.3 Construct signal flow graph from given block diagram and system equations.
- 2.3.4 Obtain the overall transmittance of control systems by signal flow graph (single input-single output systems).

### **MODULE III**

#### **3.1.0 Understand Stability of Control System**

- 3.1.1 Understand Absolute Stability, Relative stability and Marginal Stability
- 3.1.2 Understand Routh Hurwitz criterion
- 3.1.3 Solve simple problems using Routh Hurwitz criterion.

#### **3.2.0 Understand the root Locus technique to find the stability of control systems.**

- 3.2.1 Construct root locus and understand its properties.

#### **3.3.0 Understand Bode plot.**

- 3.3.1 Draw Bode plot for simple transfer functions.  $K$ ,  $Ks$ ,  $K/s$ ,  $1+Ts$ ,  $1-Ts$ ,  $1/1+Ts$ ,  $1/1-Ts$
- 3.3.2 Define and calculate gain cross over frequency, phase cross over frequency, gain margin and phase margin.
- 3.3.3 Obtain the overall transmittance of control systems by signal flow graph (single input-single output systems).

### **MODULE IV**

#### **4.1.0 Basics of MATLAB**

- 4.1.1 Schematic diagram of MATLAB's main features
- 4.1.2 MATLAB windows, Online help, Input and outputs, File types.
- 4.1.3 Saving and loading data.
- 4.1.4 Platform dependencies

#### **4.2.0 Mathematical calculations**

- 4.2.1 Simple calculations of arithmetic operations, exponential and logarithms, trigonometric functions and complex numbers.
- 4.2.2 Creation of 2D arrays,
- 4.2.3 Indexing, matrix manipulation
- 4.2.4 Comparison of array and matrix operations
- 4.2.5 Simple computations

### **CONTENT DETAILS**

#### **MODULE I (Transfer function)**

Introduction to control system - Physical systems - physical model – Mathematical model. Linear time invariant and linear time variant systems, open loop and closed loop systems.

Laplace transforms-initial value and final value theorems, Laplace transform of test inputs step, ramp, parabolic, pulse inputs.

Systems and transfer functions: -

Definition of transfer function – order of system. Transfer function of linear systems

Derivation of general equation & transfer function of mechanical translational system mechanical rotational system

Electrical circuits – R, L and C (series & parallel). Elements of Pressure systems and Thermal systems

#### **MODULE II (Block diagram Algebra & Signal flow graph)**

Time response of control system

Time Response analysis - Characteristic equation - Order of a system - Response of a System - I order with step, ramp, impulse .

Type of a system - Static error coefficients - Static position, velocity & acceleration error coefficient.  
Steady state error in terms of Static error coefficients  
Block diagram reduction rules. -Overall transfer function of control systems by block diagram reduction rules (single input-single output systems).  
Signal flow graph. Define the various parameters of the signal flow graph. Explain Mason's gain formula.

### **MODULE III (Stability Analysis)**

Routh Hurwitz criteria - problems - special cases - stability - definition - analysis. Introduction to root locus methods - construction of root locus.

Bode Plot – Draw Bode plot for simple transfer functions.  $K$ ,  $Ks$ ,  $K/s$ ,  $1+Ts$ ,  $1-Ts$ ,  $1/1+Ts$ ,  $1/1-Ts$ ,  
Definitions-gain cross over frequency, phase cross over frequency - gain margin, phase margin

### **MODULE IV (INTRODUCTION TO MATLAB)**

Basics of MATLAB – schematic diagram of MATLAB main features-windows-input-output-file types- saving and loading data-platform dependencies.

Arithmetical calculations and symbols by using MATLAB-exercises-Creating and working with arrays-exercises.

### **REFERENCES**

1. Control Systems Engineering - S.K.Bhattacharya
2. Control Engineering - Nagrath N. Gopal
3. Control systems - Nagoor Kani
4. Linear control systems - B.S. Manke
5. Rudra Prathap – MATLAB-7 - Oxford University Press.