## SEMESTER S5

## LINEAR CONTROL SYSTEMS

| | | | |
|---|---|---|---|
| **Course Code** | **PCMRT501** | **CIE Marks** | 40 |
| **Teaching Hours/Week (L: T:P: R)** | 3:1:0:0 | **ESE Marks** | 60 |
| **Credits** | 4 | **Exam Hours** | 2 Hrs. 30 Min. |
| **Prerequisites (if any)** | GCMAT101, GCMAT201, GCMAT301 | **Course Type** | Theory |

**Course Objectives:**

1. To introduce the elements of control system and its modelling
2. To introduce methods for analyzing the time response, the frequency response and the stability of systems.
3. This course enables students to systematically study the principles of system modelling

KTU SPECIAL

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | Control systems: Basic components of a Control System, Open-Loop Control Systems and Closed-Loop Control Systems, Examples of control system, Transfer functions, Block diagram reduction, Signal flow graph and Mason's gain formula.<br><br>Differential equations for mass, spring and dashpot elements, Mathematical modelling of control systems - Electrical Systems, Translational and Rotational Mechanical systems, Analogous systems-force voltage & force-current analogy - toque-voltage & torque-current analogy. | 11 |
| 2 | Time domain analysis: Continuous systems -standard test signals - step, ramp, parabolic, impulse - transient and steady state response –first order systems – second order systems, step responses of first order systems and second order systems - under damped and over damped systems - time domain specifications - steady state error – static position, velocity & | 11 |

| | | |
|---|---|---|
| | acceleration error constants. | |
| **3** | Stability of control systems and Frequency Domain Analysis:<br><br>Concept of stability - stability & location of the poles in S-plane - Routh-Hurwitz stability criterion-Root Locus Method, Construction of root locus-Effect of poles and zeros and their location on the root locus.<br><br>Frequency Response representation- Polar Plot- Relative stability: gain margin and phase margin, Stability analysis with Bode plot. | **11** |
| **4** | Compensation techniques and Case studies in Mechatronics:<br><br>Need for Cascade compensation, Cascade Compensation- PI, PD and PID controllers – tuning of PID Controller- Lead, Lag and Lead- Lag compensation- Role of control system in mechatronics-case studies Automatic temperature control, automatic traffic light control-Automatic street light control | **11** |

**Course Assessment Method**

**(CIE: 40 marks, ESE: 60 marks)**

KTU SPECIAL

**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written) | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

KTU SPECIAL

| | Course Outcome | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | To introduce the elements of control system and its modelling | **K2** |
| **CO2** | To introduce methods for analyzing the time response. | **K3** |
| **CO3** | To introduce methods for analyzing the frequency response and the stability of systems. | **K3** |
| **CO4** | Apply the knowledge of control systems in real time control applications | **K2** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

**CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | | | | | | | | 2 |
| **CO2** | 3 | 3 | | 2 | | | | | | | | 2 |
| **CO3** | 3 | 2 | 2 | | | | | | | | | 2 |
| **CO4** | 3 | 2 | | 2 | | | | | | | | 2 |

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

| **Text Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Control Systems Engineering | I. J. Nagrath and M. Gopal | New Age International Pvt Ltd, 6/e | Seventh Edition 2021 |
| 2 | Control Systems | A. Nagoorkani | RBA Publications | Fifth Edition 2020 |

KTU SPECIAL

| **Reference Books** | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| 1 | Modern Control Engineering | Katsuhiko Ogata | Pearson Education India, 5/e | Fifth Edition 2015 |
| 2 | Automatic Control Systems | Kuo | Prentice Hall | First Edition 2012 |
| 3 | Control Systems Engineering | Norman S. Nise | Wiley India Pvt. Ltd | First Edition 2018 |

| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://onlinecourses.nptel.ac.in/noc20_ee90/preview |
| **2** | https://archive.nptel.ac.in/courses/107/106/107106081/ |
| **3** | https://archive.nptel.ac.in/content/storage2/courses/112104040/lecture23/23_8.htm |
| **4** | https://archive.nptel.ac.in/courses/107/106/107106081/ |

KTU SPECIAL