| Subject Code | Subject Name | Teaching Scheme Hrs. | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ETC 405 | Control Systems | 04 | - | -- | 04 | -- | -- | 04 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | Term Work | Practical And Oral | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | | | | |
| | | Test 1 | Test 2 | Avg. Of Test 1 and Test 2 | | | | | |
| ETC 405 | Control Systems | 20 | 20 | 20 | 80 | -- | -- | -- | 100 |

**Course pre-requisite*:***
Dynamics; Differential Educations; Laplace Transforms.

**Course objectives:**
Objectives of this course are:

- To teach the fundamental concepts of Control systems and mathematical modeling of the system.
- To study the concept of time response and frequency response of the system.
- To teach the basics of stability analysis of the system

**Course outcomes:**
The outcomes of this course are**:**

- Students will be able to derive the mathematical model of different type of the systems.
- Students will understand the basic concepts of control system.
- Students will understand the analysis of systems in time and frequency domain.
- Students will be able to apply the control theory to design the conventional controllers widely used in the industries.

| Module No. | Unit No. | Topics | Hrs. |
|---|---|---|---|
| **1.0** | | **Introduction to Control System Analysis** | **08** |
| | **1.1** | **Introduction:** Open loop and closed loop systems, feedback and feed forward control structure, examples of control systems. | |
| | **1.2** | **Modeling:** Types of models, impulse response model, state variable model, transfer function model | |
| | **1.3** | **Dynamic Response:** Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types | |
| **2.0** | | **Mathematical Modeling of Systems** | **08** |
| | **2.1** | **Transfer Function models of various systems:** Models of mechanical systems, models of electrical systems, block diagram reduction, signal flow graph, and the Mason's gain rule | |
| **3.0** | | **State Variable Models** | **12** |
| | **3.1** | **State Variable Models of Various Systems:** State variable models of mechanical systems, state variable models of electrical systems | |
| | **3.2** | **State Transition Equation:** Concept of state transition matrix, properties of state transition matrix, solution of homogeneous systems, solution of non-homogeneous systems | |
| | **3.3** | **Controllability and Observability:** Concept of controllability, controllability analysis of LTI systems, concept of observability, observability analysis of LTI systems | |
| **4.0** | | **Stability Analysis In Time Domain** | **08** |
| | **4.1** | **Concepts of Stability:** Concept of absolute, relative and robust stability, routh stability criterion | |
| | **4.2** | **Root Locus Analysis:** Root-locus concepts, general rules for constructing root-locus, root-locus analysis of control systems, design of lag and lead compensators | |
| **5.0** | | **Stability Analysis In Frequency Domain** | **08** |
| | **5.1** | **Introduction**: Frequency domain specifications, response peak and peak resonating frequency, relationship between time and frequency domain specification of system, stability margins | |
| | **5.2** | **Bode plot:** Magnitude and phase plot; Method of plotting Bode plot; Stability margins on the Bode plots; Stability analysis using Bode plot. | |
| | **5.3** | **Nyquist Criterion:** Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins. | |
| **6.0** | | **Optimal and Adaptive Control Systems** | **08** |
| | **6.1** | **Optimal control:** Performance measure for optimal control problems, the principle of optimality, concept of dynamic programming, fundamental of a single Function, Functions involving several independent Functions, constrained minimization of Functions | |
| | **6.2** | **Adaptive Control Systems:** Model reference adaptive control approach for controller design, Neuro-Fuzzy adaptive control (only concept) | |
| | | **Total** | **52** |

**Text books:**

1. Nagrath, M.Gopal, *"Control System Engineering"*, Tata McGraw Hill.
2. K.Ogata, *"Modern Control Engineering, Pearson Education",* III[rd] edition.
3. Benjamin C.Kuo, *"Automatic Control Systems, Eearson education"*, VII[th] edition.

**Reference Books:**

1. Madam Gopal, Control Systems Principles and Design, Tata McGraw hill, 7th edition,1997.
2. Normon, Control System Engineering, John Wiley & sons, 3rd edition.
3. Curtis Johnson, Process Control Instrumentation Technology, Pearson education fourth edition.
4. Dhanesh N. Manik, *"Control Systems"*, Cengage Learning, 1[st] edition, 2012.
5. Sastry S. S., *"Adaptive Control"*, PHI.

**Internal Assessment (IA):**
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

**End Semester Examination**:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3: Question No.1 will be compulsory and based on entire syllabus.
4: Remaining question (Q.2 to Q.6) will be selected from all the modules.