



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04000041

Subject Name: Control Systems

WEF Academic Year :	2025-26
Semester :	4
Category of the Course :	PCC-07

<b>Prerequisite :</b>	Knowledge of Linear algebra, Differential equations and Laplace transform.
<b>Rationale :</b>	<p>This course explores the fundamentals of systems and control. The course has following primary focuses:</p> <ol style="list-style-type: none"><li>(1) Understanding and predicting behavior of the system.</li><li>(2) Differentiate between the open loop and closed loop systems.</li><li>(3) Design and analysis of closed loop control systems.</li><li>(4) Analyze the condition for system stability.</li><li>(5) Understand different methods for finding the relative and absolute stability of the system.</li><li>(6) Evaluate the performance of the system for different excitations.</li></ol>

## Course Outcome :

After Completion of the Course, Student will able to :

No	Course Outcomes	RBT Level*
01	Analyze and Evaluate system behavior in time and frequency domains based on the mathematical model of the system.	AN
02	Apply control theory to linear system for system modeling using differential equations and transfer function realizations.	UN
03	Analyze and apply all the stability techniques for closed loop system performance parameters.	AN
04	Comprehend the need of different types of controllers and compensators to obtain the required dynamic response of the system.	UN, AP
05	Synthesis system equations for state space models of linear systems.	AP, AN

\*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04000041

Subject Name: Control Systems

### Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/ CA (I)	TW/S L (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

\* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.

### Course Content :

Sr. No.	Course Content	Total Hrs	% Weightage
1	Introduction to Control Systems: Introduction, Brief History of Automatic Control, Examples of Control Systems, Engineering Design, Mechatronic Systems, The Future Evolution of Control Systems.	2	4
2	Mathematical Models of Systems: Differential Equations of Physical Systems, Linear Approximations of Physical Systems, The Laplace Transform, The Transfer Function of Linear Systems, Block Diagram Models, Signal-Flow Graph Models.	5	12
3	Feedback Control System Characteristics: Error Signal Analysis, Sensitivity of Control Systems to Parameter Variations, Disturbance Signals in a Feedback Control System, Control of the Transient Response, Steady-State Error, The Cost of Feedback.	3	8
4	The Performance of Feedback Control Systems: Test Input Signals, Performance of Second-Order Systems, Effects of a Third Pole and a Zero on the Second-Order System Response, Transient Response, The Steady- State Error of Feedback Control Systems, Performance Indices, The Simplification of Linear Systems.	5	10
5	The Stability of Linear Feedback Systems: The Concept of Stability, relative stability analysis, Routh-Hurwitz criteria.	3	10



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04000041

Subject Name: Control Systems

6	The Root Locus Method: The Root Locus Concept. The Root Locus Procedure, Parameter Design by the Root Locus Method, Sensitivity and the Root Locus, Three-Term (PID) Controllers.	5	12
7	Frequency Response Methods: Frequency Response Plots, Frequency Response Measurements, Performance Specifications in the Frequency Domain, Log Magnitude and Phase Diagrams.	4	8
8	The Design of Feedback Control Systems: Approaches to System Design, Cascade Compensation Networks, Phase-Lead Design Using the Bode Diagram, Phase-Lead Design Using the Root Locus, System Design Using Integration Networks, Phase-Lag Design Using the Root Locus, Phase-Lag Design Using the Bode Diagram, Design on the Bode Diagram Using Analytical Methods.	6	12
9	Stability in the Frequency Domain: Mapping Contours in the s-Plane, The Nyquist Criterion, Relative Stability and the Nyquist Criterion, Time-Domain Performance Criteria in the Frequency Domain, System Bandwidth, The Stability of Control Systems with Time Delays.	6	12
10	State Variable Models: The State Variables of a Dynamic System, The State Differential Equation, Signal-Flow Graph and Block Diagram Models, Alternative Signal-Flow Graph and Block Diagram Models, The Transfer Function from the State Equation, The Time Response and the State Transition Matrix.	6	12
	<b>Total</b>	<b>45</b>	<b>100</b>

## Reference Book :

1. Control Systems Engineering by Nagrath and Gopal New Age Publication
2. Modern Control Engineering by Katsuhiko Ogata, 4th Edition, Prentice Hall of India.
3. Modern Control System by Richard C. Dorf and Robert H. Bishop, 11th Edition Person Int.
4. Automatic Control Systems by Benjamin C. Kuo, 8th Edition, Farid Golnaraghi, John Wiley & Sons.
5. Feedback and Control Systems by Joseph J Distefano 2nd Edition TMH

## Suggested Course Practical List :

1. Simulation of DC motor working
2. Simulation of synchros
3. Generating standard test signals i.e. step, ramp, unit impulse on a simulator
4. Analysis of time response of second order system.



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04000041

Subject Name: Control Systems

5. Effect of P, PD, PI, PID Controller on a second order systems.
6. Plotting root locus of a given transfer function using a simulator.
7. Temperature control using PID.
8. Plotting phase magnitude plot of a given transfer function with a simulator.
9. Obtaining frequency response of a common emitter amplifier and plotting on a Bode plot.
10. Simulation of a given transfer function using OPAMPs.
11. Stability Analysis ( Root locus, Bode, Nyquist) of Linear Time Invariant System.
12. Study of a PLL as a closed loop control system on a simulator.

### List of Open Source Software/learning website:

Ng-spice/MATLAB, www.nptel.com

### List of Laboratory/Learning Resources Required:

SCILAB/MATLAB

### Activities suggested under Problem Based Learning:

S1. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Problem solving/Coding using C, C++, Python, SCILAB, MATLAB, MS-EXCEL or any other relevant software	5 small coding based assignment of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.



# GUJARAT TECHNOLOGICAL UNIVERSITY

**Program Name: Bachelor of Engineering**

**Level: UG**

**Subject Code: BE04000041**

**Subject Name: Control Systems**

6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure  Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 h	Depending on the complexity of the Application/Software

Note:

- All the suggested activity should be related to the subject.
- The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Subject Code: BE04000041

Subject Name: Control Systems

---

3. Rubrics for the evaluation can be prepared by the faculty.

\* \* \* \* \*