GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: CONTROL SYSTEM FOR POWER ELECTRONICS
(COURSE CODE: 3352405)

Diploma Programme in which this course is offered	Semester in which offered
Power Electronics	5th Semester

1. RATIONALE

With the advancement of technology, control techniques have taken rapid strides with the introduction of different types of power electronics, electronics, and instrumentation devices. This course is intended to enable the student to understand the facts, concepts, principles and applications of the control system and transfer function. After studying this course students will be able to apply these concepts to control different types of electrical and electronics systems used in the industry. Drill and practice in the lab would also prove useful to develop the practical skills.

2. LIST OF COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

Maintain stable control system.

3. COURSE OUTCOMES

The theory should be taught and practical should be undertaken in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes

   i. Identify different types of control systems.
   ii. Determine transfer function and time response of a control system useingLaplace transform.
   iii. Analyze the time response specifications.
   iv. Develop mathematical model of various physical system to arrive at transfer function.
   v. Calculate absolute and relative stability of a control system using R-H criterion.

4. TEACHING AND EXAMINATION   SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
4	0	2	6	70	30	20	30	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical;   **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5.   COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (Major outcomes in cognitive domain)	Topics and Sub-topics
Unit I Introduction to Control Systems	1a. Describe the significance of control system in engineering. 1b. Differentiate between Open and closed loop control system.	1.1. Need for control system 1.2. Open-loop, Closed-loop, 1.3. Open loop and closed loop control systems.
	1c. Describe feedback closed loop system and its effects.	1.4. Significance of feedback, 1.5. Effect of feedback on System gain, stability, Noise and sensitivity.
	1d. Describe the need for servomechanism with examples 1e. Describe the working of Automatic Tank level control system and Position control system 1f. Describe the various control system using block diagram 1g. Apply block diagram reduction techniques.	1.6. Servomechanism: DC Closed loop control system. AC Closed loop control system. 1.7. Block diagram of a control system 1.8. Block diagram reduction techniques.
UnitII Laplace Transform and Transfer Function	2a. Explain the significance of Laplace transform in control system. 2b. Use Laplace transforms to find transfer function of control system.	2.1. Transformation from time domain function to S-domain function and vice versa. 2.2. Basic Laplace transform theorem
	2c. Define transfer function in terms of poles and zeros.	2.3. Transfer Function: 2.4. Poles and zeros of Transfer function and its relationship with impulse response
	2d. Find the transfer function of open loop and closed loop control system.	2.5. Transfer function of open and Closed loop control system.
	2e. Find out transfer function of electrical networks.	2.6. Transfer function of electrical networks: R-L, R-C, L-C and R-L-C networks.
Unit III Time Response Analysis of Control System	3a. State the features of Step, Ramp, Parabolic and Impulse signal 3b. Distinguish between type and order of control system with examples.	3.1. Input test signals: Step, Ramp, Parabolic and Impulse signal. 3.2. Type and order of control system .
	3c. Describe Time response of first order control system using Unit-impulse, Unit-Step and Unit-Ramp Response with sketches.	3.3. Time response of a first order control system. Unit-impulse, Unit-Step and Unit-Ramp Response.

Unit	Major Learning Outcomes (Major outcomes in cognitive domain)	Topics and Sub-topics
	3d. Describe Time response of first order control system using Unit-Step with sketches. 3e. Differentiate between critical, under damped, undamped and over damped control systems 3f. Distinguish Rise time, Peak time, Peak overshoot, Settling time and Steady state error of a control system	3.4. Time response analysis of a second order control system subjected to unit-step input. 3.5. Critical, under damped, undamped and over damped system. 3.6. Rise time, Peak time, Peak overshoot, Settling time and Steady state error and their significance.
	3g. Explain working of various control system controllers. 3h. Explain the effect of K_d, K_i and K_p on the performance of control system.	3.7. Response of Proportional (P), Derivative (D), Integral (I) and Proportional plus integral plus derivative control (PID) controller. 3.8. Effect of varying K_d, K_i and K_p on the performance of control system.
Unit IV Mathematical Models of Physical system	4a. Prepare a mathematical models for different physical systems such as servomotors and such others	4.1. Mathematical model for various electrical networks, Servomotors, Separately exited D.C. Generator, error detectors.
Unit V Stability Analysis of Control system	5a. State the necessary conditions for the stability 5b. Apply Routh – Hurwitz criterion to find out absolute stability and Relative stability.	5.1. Stability, Relative and absolute stability, Need of stability in control system. 5.2. Necessary conditions for the stability. 5.3. Routh-Hurwitz criterion: Absolute stability, Relative stability.

6.   SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Control Systems	14	6	6	6	18
II	Laplace Transform and Transfer Function	9	3	4	4	11
III	Time Response Analysis of Control System	15	4	7	7	18
IV	Mathematical Models of Physical system	10	3	5	4	12
V	Stability Analysis of Control system	8	3	4	4	11
	Total	**56**	**19**	**26**	**25**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

7.   SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills *(outcomes in psychomotor and affective domain)* so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

*Note: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (outcomes in Psychomotor Domain)	Approx. Hrs. Required
1.	I	Test the performance of open loop and closed loop control system with suitable example.	2
2.	I	Test the performance of servomechanism.	4
3.	III	Plot the output time response of a first order system.	2
4.	III	Plot the output time response of a second order system.	2
5.	III	Determine the performance of time response specifications for a second order system.	4
6.	III	Test the performance of type 0 control system.	2
7.	III	Test the performance of type 1 control system.	2
8.	III	Test the performance of type 2 control system.	2
9.	III	Test response of control system with P control.	2
10.	III	Test response of control system with I control.	2
11.	III	Test response of control system with D control.	2
12.	III	Test response of control system with PID control.	4
13.	IV	Prepare Mathematical Model for AC and DC Servo motors.	4
14.	IV	Prepare Mathematical Model for Different Electrical Networks.	4
15.	V	Find out stability for given control system using R-H criterion.	4
* The above Experiment/s may also be performed using MATLAB/ SIMULINK also			
TOTAL			42

8.   SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

i.   Prepare chart for open loop and closed loop control system
ii. Prepare tutorial for block diagram using block diagram reduction techniques.
iii. Prepare model for servomechanism.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

i.   Give as many simple numerical as possible to students as assignments and ask students to present their solutions in the class.
ii. Ask students to compare results from practical with the expected theoretical result and find out the reasons for difference.

10.   SUGGESTED LEARNING RESOURCES

(A) List of Books

S.No.	Title of Books	Author	Publication
1	Linear control system	Manke B.S.	Khanna publication, New Delhi. Latest edition
2	Modern control engineering	Ogata K.	PHI Learning, New Delhi. Latest edition
3	Control system engineering	Nagrath J. J., Gopal M.	New Age Publications, New Delhi. Latest edition
4	Control Engineering	Bandopadhyay M. N.	PHI Learning, New Delhi. Latest edition
5	Control system analysis and design	Agrawal K.K.	Khanna publication, New Delhi. Latest edition

B.   List of Major Equipment/Materials

i.   Function generator
ii. D.C. Power supply
iii. Type 0,1 and 2 control system KIT.
iv. MATLAB latest version.
v.   P,I,PID kit.

C   List of Software/Learning Websites

i.   www.mathworks.in/
ii. www.elearningtrendcontrols.com/
iii. http://csd.newcastle.edu.au/
iv. http://www.controleng.com/

11.   COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. S. L. Dhoriyani**, LPE, Dept. of Power Electronics, Dr. S. & S. S. Ghandhy College of Engg. and Technology, Surat

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. A.S.Walkey**, Associate Professor, Dept. of Electrical & Electronics Engg,
- **Dr. Joshua Earnest**, Professor, Dept. of Electrical & Electronics Engg,