Name of Institute: Indus Institute of Technology and Engineering

Name of Faculty: Dr. A D Dhass

Course code: ME0635
Course name : Control of Robotic Systems (OE-7)

Pre-requisites : Basic of Mechanical Engineering, Basic of Electrical Engineering

Teaching Scheme					Examination Scheme				
					Theory		Practical		
L*	T*	P*	Cr	Hrs	CIE	ESE	CIE	ESE	TOTAL
2	0	2	3	4	60	40	60	40	200

Credit points: 3
Offered Semester: VI

Course Coordinator

Full name: Dr.A D Dhass
Department with siting location: EME Lab (B-103) , FF, Bhanwar Builiding
Telephone: 3113
Email: addhass.me@indusuni.ac.in
Consultation times: All workimg Saturdays

Students will be contacted throughout the session via mail with important information relating to this course.

Course Objectives

This course aims to develop the

1) Understanding of control systems,
2) Designing
3) Application

Course Outcomes (CO)

After learning the course, the students should be able to,

- **CO1**: To learn the fundamentals of MATLAB software
- **CO2**: Know the transfer function, signal flow graph representation of linear systems & their controlling actions.
- **CO3**: Understand concept of time, frequency response as well as concept of state-space models and their relation to frequency domain
- **CO4**: Understand the methodology for modelling dynamic systems with concept of stability

Course Outline

Key in topics to be dealt:

1. Matlab software
2. Types of controllers.
3. Closed loop system, Block diagram and signal flow graph
4. Time response and Frequency response system
5. State space modelling system

Method of delivery

(Face to Face Lecture), PPT & Video, Self-study material, Problem Based Learning)

Study time

(How many hours per week including class attendance)

	Lecture	Tutorial	Practical
No of hours	2	0	2

CO-PO Mapping (PO: Program Outcomes)

PO	**PO**											
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	-	-	--	3	2	1	1	2	2	1	3
CO2	3	2	-	2	3	-	-	-	1	-	-	-
CO3	3	2	2	2	3	-	-	-	2	-	-	-
CO4	2	2	3	3	3	1	2	2	2	1	2	1

Blooms Taxonomy and Knowledge retention(For reference)

(Blooms taxonomy has been given for reference)

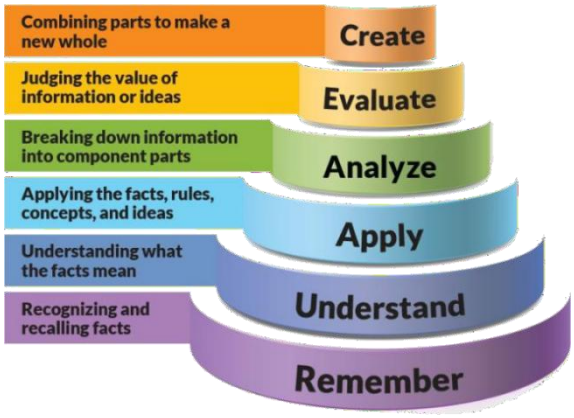

Figure 1: Blooms Taxonomy

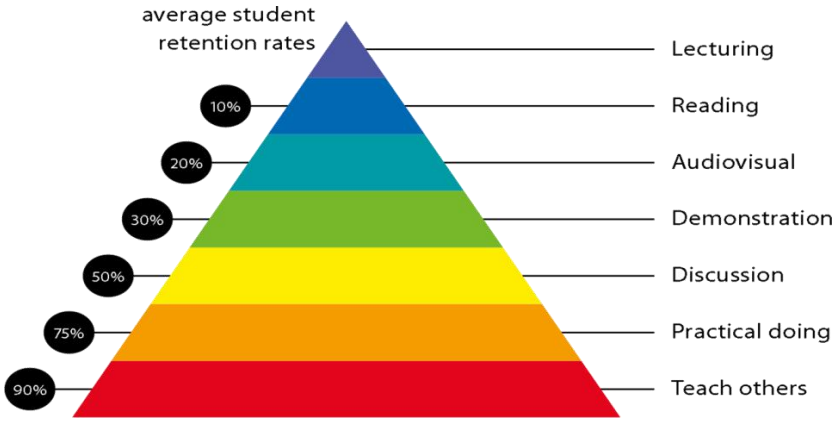

Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of_____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**

Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work: LIST OF PRACTICALS

1. Reviewing the fundamentals of MATLAB software
2. Determination of transfer function parameters of field-controlled DC Servo motor
3. Stability analysis of linear system
4. Plot the Root Locus
5. Basics of Simulink
6. Use of Simulink for ROS
7. AC/DC Position control system
8. Design and perform Nyquist and Bode Plot
9. Stepper Motor control system
10. Implementation of P, PI and PID controller
11. Interfacing of Hardware and software with MATLAB
12. Programming and simulation of a robot in MATLAB

Lecture/tutorial times

(Give lecture times in the format below)

As per Time Table

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Details of referencing system to be used in written work

Text books

1. M. Gopal, Control Systems, McGraw-Hill (2012)
2. K. Ogata, "Modern Control Engineering", Prentice Hall India (2009).

Reference Books

1. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, (2005).
2. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, Addison- Wesley (2003).
3. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014).
4. Thomas Kailath, "Linear Systems", Prentice Hall (1980). 7. AlokSinha, "Linear Systems: Optimal and Robust Control", Taylor & Francis (2007).

Additional Materials

https://onlinecourses.nptel.ac.in/noc20_me03/preview

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Tentative CIE Theory 60 Marks Bifurcation		Tentative Duration
10 Marks	Assignment -1	After completion of each Topic
10 Marks	Assignment-2	After completion of each Topic
40 Marks	Mid Sem exam	As per academic Calendar
Tentative CIE Practical 60Marks Bifurcation		**Tentative Duration**
10 Marks	Lab Participation	Academic Session
50 Marks	Experiment perform and Practical Journal book submission	After completion of each Topic

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment).

Course schedule (subject to change)

Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
Week 1	Unit 1: Basics, Language Fundamentals, Mathematical Operations	1 , 2	Assignment Submission
Week 2	Unit 1: Graphics, Programming. Unit 2: Control Systems: Types of Controllers, Introduction to closed loop control	1,2	Assignment Submission
Week 3	Unit 2: Differential Equation, Transfer function, Block diagram.	2,3	Assignment Submission, Quiz
Week 4	Unit 2: Signal Flow Graph. Unit 3 : Time Response, Routh-Hurwitz test,	3,4	Assignment Submission
Week 5	Unit 3: relative stability, Root locus design	3,4	Assignment Submission
Week 6	Unit 3: construction of root loci, phase lead and phase-lag design	4	Assignment Submission
Week 7	Unit 3 : lag-lead design, Frequency response, Bode, polar plot	4,6	Assignment Submission
Week 8	Unit 3 : Nyquist plot. Unit 4 : Concept of states	4,6	Assignment Submission, Quiz
Week 9	Unit 4 : state space model, different form, controllability, observability;	5,6	Assignment Submission, Quiz
Week 10	Unit 4 : pole placement by state feedback, observer design	4,6	Assignment Submission, Quiz
Week 11	Unit 4 : P, PI & PID Controller, control law partitioning	5,6	Assignment Submission, Quiz
Week 12	Unit 4 : modelling and control of a single joint.	4,6	Assignment Submission, Quiz