BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

SECOND SEMESTER 2020-21
COURSE HANDOUT

Date: 04.01.2021

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **EEE/INSTR F242**
Course Title : **Control Systems**
Instructor-in-Charge : **Dr. B.K. Mukherjee**
Instructor(s) : **Dr. B.K. Mukherjee, Dr. H.O. Bansal**
Tutorial/Practical Instructors: Dr. B.K. Mukherjee, Dr. H.O. Bansal, Dr. K.K. Gupta, Dr. P. Mishra, Dr. A.R. Gautam, Mr. A. Jahagirdar

1. Course Description: Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

2. Scope and Objective of the Course: Feedback or automatic control is an essential feature of numerous industrial processes, scientific instruments and even commercial, social and management situations. A thorough understanding of the elementary principles of this all-embracing technology is of great relevance for all engineers and scientists in general and Electrical & Electronics engineers in particular. This course tries to bring out the basic principles of Feedback Control Systems.

3. Text Books: Nagrath I. J. and M. Gopal, Control Systems Engineering, New Age Publishers

4. Reference Books:

(i) Kuo, B. C., and Golnaraghi, F., Automatic Control Systems, John Wiley & Sons, 8th Ed, 2003.

(ii) K. Ogata, Modern Control Systems, Pearson Education, 4th Ed., 2002

(ii) Drof, R. C., and Bishop, R. H., Modern Control Systems, Addison Wesley, 7th Ed, 1995.

5. Course Plan:

Module No.	Lecture Session	Reference	Learning outcomes
1. Introduction (Lec1-3)	Introduction; Different types of systems and signals; Various terminologies; Open loop and closed loop control; A brief history; Examples from various fields	Ch.1 of Textbook, Lecture Notes	General understanding of the concept of control systems; familiarization with various terms and their significance; familiarization with various application domains.
2. Mathematical Modelling (Lec 4-10)	Introduction to math modelling; Modelling of electrical and mechanical systems; Block diagram representation and simplification; Properties of feedback control	Ch. 2 & 3 of Textbook, Lecture Notes	Learning how to derive mathematical models and transfer functions of electrical, mechanical, electromechanical systems; Understanding block diagram representation and simplification; Mathematical

			understanding of properties of closed loop control systems
3. Control Systems Components (Lec 11-16)	AC and DC electrical components such as armature and field controlled DC servomotors; AC servomotor; Stepper motor; Synchro; Hydraulic and pneumatic components	Ch.4 of Textbook, Lecture Notes	Learning about various control systems components and their use in various examples; Forming block diagrams and deriving transfer functions
4. Introduction to Discrete-time Systems (Lec 17-18)	Representation of Discrete Time systems; Sampling and reconstruction.	Ch.11 of Textbook, Lecture Notes	Learning about mathematical representation of Discrete Time systems vis-a-vis Continuous Time systems
5. Introduction to State Space Modelling (Lec 19-20)	Introduction to State Space modelling approach; Examples; Comparison with Transfer Function approach; Interconversions between transfer functions and state space models	Ch.12 of Textbook (initial parts), Lecture Notes	Learning about State Space representation of dynamic systems vis-a-vis transfer function representation
6. Time Domain Analysis (Lec 21-28)	Stability determination using R-H criteria; Applying R-H criteria to Discrete Time systems; Various test signals and time response of 1st and 2nd order systems to them; Time domain specifications and their expressions for prototype 2nd order systems; Steady state errors; Introduction to PID and Lead/Lag type controllers	Ch. 5,6 &11 of Textbook, Lecture Notes	Learning how to carry out stability and transient response analysis of dynamic systems to different excitations; Understanding the effects of PID type controllers
7. Root Locus Technique (Lec 29-31)	Concept of root locus; Method of drawing root locus plot; Various examples	Ch.7 of Textbook, Lecture Notes	To draw root locus for various systems and therefrom infer information on time response and stability
8. Frequency Domain Analysis-I (Lec 32-34)	Concept of frequency domain and comparison with time domain; Frequency domain specifications; Polar plot; Gain and Phase margins	Ch.8 & 9 of Textbook, Lecture Notes	To learn how to obtain various frequency response plots of systems and how to use them for stability and performance analysis
9. Frequency Domain Analysis-II (Lec 35-39)	Bode plot; Transfer function identification from Bode plot; Non-minimum phase systems; Nyquist stability criterion	Ch.8 & 9 of Textbook, Lecture Notes	Do
10. Introduction to Design and Concluding Remarks (Lec 40)	Various classical control architectures; Lead, Lag controller design philosophy from Bode plot; A brief overview of further topics on Control Systems	Ch.10 of Textbook, Lecture Notes	Getting a flavour of how to design classical controllers and a flavour of more advanced aspects of the area of control engineering

6. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of component (Close Book/ Open Book)
Mid-Semester Test	2 Hrs.	30%	<TEST_1>	OB
Comprehensive Examination	1.5 Hr.	40%	<TEST_C>	OB
Quizzes and Take Home Assignment	15 Min.	30%		OB

7. Chamber Consultation Hour: To be announced in the class

8. Notices: All notices will be displayed on NALANDA

9. Make-up Policy: Makeup will be granted to extremely genuine cases only.

10. Note (if any):

Instructor-in-charge
Course No. EEE/INSTR F242