DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE PLAN – PART I				
Degree	**M.Tech.**	**Course Title**	**LINEAR AND NON-LINEAR SYSTEMS THEORY**	
Course Code	**EE653**		**No. of Credits**	**03**
Course Code of Pre-requisite subject(s)	**EE303, Linear algebra**			
Session	**JULY 2021**		**Section**	**Power Electronics**
Name of Faculty	**Dr. V. Sankaranarayanan**		**Department**	**EEE**
Name of Course Coordinator(s) (if, applicable)			**--**	
Email	**vsankar@nitt.edu**		**Telephone No.**	**0431-2503268**
Course Type	√ **Core course**	☐ **Elective course**		

SYLLABUS (APPROVED IN BoS)

Introduction to state space modeling, modeling of physical systems. Solution to vector differential equations and state transition matrix.

Stability analysis of linear systems. Controllability and Observability definitions and Kalman rank conditions. Detectability and Stabilizability, Kalman decomposition.

State feedback controller design using pole placement. Observer design using Kalman filter algorithm. LQR and LQG controller design.

Introduction to nonlinear systems. Phase plane analysis of nonlinear system using linear approximation. Limit cycle and periodic solutions. Singular points (equilibrium points) and qualitative behavior near singular points.

Stability of nonlinear systems. Lyapunov direct and indirect methods. Input-to-state stability and relative stability.

COURSE OBJECTIVES

The main objective of this course is to understand the fundamental of physical systems in terms of its linear and nonlinear models. Exploit the properties of linear systems such as controllability and observability.

COURSE OUTCOMES (COs)	**Aligned Programme Outcomes (POs)**
On completion of the course, the students are expected to be able to: 1. Understand and model physical systems using state vectors. 2. Analyze the stability of linear systems. 3. Design state feedback controllers and observers. 4. Understand and analyze non-linear systems using linear approximations. 5. Inspect the stability of non-linear systems by direct and indirect methods.	

Programme Outcomes (POs) / COs	1	2	3	4	5
1	M	H	H	H	H
2	M	H	H	H	H
3	H	H	H	H	H
4	L	M	M	M	M
5	L	M	M	M	M
6	M	M	M	M	M
7	M	M	M	M	M

COURSE PLAN – PART II			
COURSE OVERVIEW			
The main goal of this course is to provide a solid background in practical implementation of power converters and drives			
COURSE TEACHING AND LEARNING ACTIVITIES			
S.No.	**Week**	**Topic**	**Mode of Delivery**
1.	2nd week of September '21 (7-10)	Introduction, historical perspective of control theory	Lecture/ Tutorial C & T / PPT or Any suitable mode
2.	3rd week of September'21 (13-17)	Introduction to modelling	
3.	4th week of September '21 (20-24)	Modelling of physical systems in state space format	
4.	5th week of September'21 (27-1)	Definition of state and properties of state transition matrix	
5.	2nd week of October '21 (4-8)	Solution to vector differential equation	
6.	3rd week of October '21 (11-15)	Introduction to controllability and observability, Concept of stabilizability and detectability **Assessment-1**	
7.	4th week of October '21 (18-22)	Kalman decomposition	
8.	5th week of October '21 (25-29)	Controller design using pole placement design of controller	
9.	1st week of November '21 (1-5)	Observer design	Lecture/ Tutorial C & T / PPT or Any suitable mode
10.	2nd week of November '21 (8-12)	Stability of controller design based on the observer using separation principle	
11.	3rd week of November '21 (15-19)	Introduction to non linear systems, phase plane analysis **Assessment-2**	

12.	4th week of November '21 (22-26)	Multiple equilibrium points	
13.	5th week of November '21 and 1st week of December '21 (29-3)	Stability of non linear system using Lyapunov direct method	
14.	2nd week of December '21 (6-10)	**Compensation assessment**	
15.	3rd week of December '21 (13-17)	Instability theorem, lasalle's invariance principle	
16.	4th week of December '21 (20-24)	**Assessment-4**	

C & T : Chalk and Talk and PPT : Power Point

COURSE ASSESSMENT METHODS

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Assessment-1 (1st and 2nd unit)	October third week	60 Minutes	25
2	Assessment-2 (3rd and 4th unit)	November third week	60 Minutes	25
3	Assessment-3 Assignment/ Open book test/ Quiz	Details will be informed later	60 Minutes	20
CPA	Compensation Assessment (First 4 units)	December second week	60 Minutes	25
5	Assessment-4 (All units)	December forth week	60 Minutes	30

Note:

1. Exact date and time for the assessments will be as per the Office of the Dean (Academic) instructions.
2. Attending all the assessments (i.e., Assessment 1 to 4) is MANDATORY for every student.
3. If any student is not able to attend Assessment-1/ Assessment-2 due to genuine reason, he/she is permitted to attend the Compensation Assessment (CPA) with 25% weightage (25 marks).
4. In any case, CPA will not be considered as an improvement test.

Grading the students

1. Grading will be based on the clusters (range) of the total marks (all the assessments i.e., Assessment 1 to 4, put together for each student) scored. For grading, Gap theory or Normalized curve method will be used to decide the clusters (range) of the total marks.

2. The passing minimum shall be as per the Office of the Dean (Academic) instructions. Hence, every student is expected to score the minimum mark to pass the course as prescribed by the Office of the Dean (Academic). Otherwise the student would be declared fail and 'F' grade will be awarded.

ESSENTIAL READINGS : Textbooks, reference books Website addresses, journals, etc

1. Ogata, K., 'Modern Control Engineering', Prentice Hall of India, 2010.

2. C.T. Chen, 'Linear Systems Theory and Design', Oxford University Press, 3rd Edition, 1999.

3. M. Vidyasagar, 'Nonlinear Systems Analysis', 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey 07632.

4. Hassan K. Khalil, 'Nonlinear Systems', Pearson Educational International Inc. Upper Saddle River, 3rd Edition.

COURSE EXIT SURVEY (mention the ways in which the feedback about the course is assessed and indicate the attainment also)

Feedback from the students during class committee meetings

Anonymous feedback through questionnaire

COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

CORRESPONDENCE

1. All the students are advised to check their NITT WEBMAIL regularly. All the correspondence (schedule of classes/ schedule of assessment/ course material/ any other information regarding this course) will be done through their webmail.

2. Queries (if required) may be emailed to me / contact me during 10.30 am to 11.30 am

on Monday and Wednesday with prior intimation for any clarifications.

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

3. At least **75% attendance** in each course is **mandatory.**
4. A maximum of 10% shall be allowed under On Duty (OD) category.
5. Students with less than 65% of attendance shall be prevented from writing the final assessment and shall be awarded 'V' grade.

ACADEMIC DISHONESTY & PLAGIARISM

6. Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
7. Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
8. The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.
9. The above policy against academic dishonesty shall be applicable for all the programmes.

FOR APPROVAL

Course Faculty **CC-Chairperson** Dr. S. Kayalvizhi **HOD** Approved by HoD