NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING

COURSE PLAN – PART I			
Name of the programme and specialization	**M.Tech. PROCESS CONTROL AND INSTRUMENTATION**		
Course Title	**MODERN CONTROL ENGINEERING**		
Course Code	**CL 653**	**No. of Credits**	**3**
Pre-requisites	**-**		
Session	**July 2020**		
Name of Faculty	**Dr. Dhanalakshmi K.**	**Department**	**ICE**
Official Email	**dhanlak@nitt.edu**	**Telephone No.**	**0431 250 3360**
Course Type	**CORE COURSE**		

Syllabus (approved in BoS)

State-space Models – Review of vectors and matrices, Canonical Models from Differential Equations and Transfer Functions, Interconnection of subsystems.

Analysis of Linear State Equations – First order scalar differential equations, System modes and modal decomposition, State Transition Matrix, Time-varying matrix case.

Lyapunov's stability theory for Linear Systems – Equilibrium points and stability concepts, Stability definitions, Linear system stability, The Direct method of Lyapunov, Use of Lyapunov's method in feedback design.

Controllability & Observability – Definitions, Controllability/Observability Criteria, Design of state feedback control systems, Full-order and Reduced-order Observer Design, Kalman canonical forms, Stabilizability & Detectability.

Digital Control Systems, Closed-loop Feedback Sampled-Data Systems, Stability Analysis, Implementation of Digital Controllers.

COURSE OBJECTIVES

1. To introduce and teach advanced methods and techniques of linear system analysis and design from modern and digital control theory, and emphasize their interrelation.
2. To introduce mathematical modeling, analysis, and design of a larger class of systems in a unified framework.

MAPPING OF COs with POs

Course Outcomes	Programme Outcomes (PO)
1. The student is exposed to an appropriate modern paradigm for the study of larger scale multi-input-multi-output systems.	1, 3, 4, 5, 6
2. The student understands the importance of linear algebra and matrix theory in designing practical control systems.	1, 3, 4, 5, 6
3. The student is motivated to study more general systems and their stability using Lyapunov's theory.	1, 3, 4, 5, 6
4. The student learns to implement modern control systems using a digital computer in the loop.	1, 3, 4, 5, 6

COURSE PLAN – PART II

COURSE OVERVIEW

This course will introduce students to modern control theory based on state space methods and optimization. The focus will be primarily on modelling, analysis and controller design of continuous time, Lumped Parameter Linear Time Invariant systems. The course will emphasise, through examples how to apply modern control techniques to system models using suitable computer software package in the analysis and design of control systems.

COURSE TEACHING AND LEARNING ACTIVITIES

S. No.	Week/Contact Hours	Topic	Mode of Delivery
1 - 2	1	Review of control concepts and classical control system.	Online teaching through MS Teams - Power point presentations - Digital Board and stylus Demonstration of case studies
3 - 4	2, 3	Introduction and outline of the course. Time - domain modeling. Comparison with modeling in the frequency - domain.	
5 - 10	4, 5	State-space Models: Basic definitions and State space representations. Canonical Models from Differential Equations and Transfer Function. Interconnection of subsystems. State space model to transfer function. Pictorial representation - State transition diagram	
11 – 17	6, 7	Analysis of Linear State Equations – First order scalar differential equations, System modes and modal decomposition, State Transition Matrix, Time-varying matrix case.	
18 – 23	8, 9, 10	Lyapunov's stability theory – Equilibrium points and stability concepts, Stability definitions, Linear system stability, The Direct method of Lyapunov.	
24 – 29	10, 11, 12	Controllability & Observability – Definitions, Controllability and Observability Criteria, Design of state feedback control systems, Full-order and Reduced-order Observer Design, Kalman canonical forms, Stabilizability & Detectability. Use of Lyapunov' s method in feedback design	
30 - 36	13, 14	Digital Control Systems, Closed-loop Feedback Sampled-Data Systems, Stability Analysis, Implementation of Digital Controllers.	

COURSE ASSESSMENT METHODS

S. No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	Assessment 1	After the first month of commencement of classes **Units 1 and 2**	1.5 hours	20
2	Assessment 2	At the third month **Units 3 and 4**	1.5 hours	20
3	Assessment 3	Any time during the semester **Assignment, Presentation, viva,quiz, attentiveness in class**	1 hour	30
CPA	Compensation Assessment* Allowed only for any of Assessment 1 and 2	**Units 1 to 4**		20
4	Final Assessment *	At the end of the semester **All 5 units**	3 hour	30

***mandatory; refer to guidelines on page 4**

COURSE EXIT SURVEY

Feedback may be provided during the Class Committee Meeting.
Descriptive feedback shall be collected by the faculty during the mid of the semester.
A formal online feedback will be collected by the institute at the end of the semester.

COURSE POLICY

Every student is required to appear for each assessment and is expected to obtain above 50 % of the weightage to expect a pass grade in the course.
Prior permission should be obtained from the faculty member or at least kept informed (only in case of emergency) **through email**, if a student would be unable to appear for any assessment. If this is not adhered to, request of any kind will not be accepted for a student to be permitted to appear for the Compensatory Assessment.
A student who misses any or both of the assessments 1 and 2 will get an opportunity to compensate for only 20 % weightage.
Compensatory assessment will be conducted 1 week prior to Assessment 4 (the end semester examination).

Grading policy– Relative grading based on normalized curve will be followed.

Withdrawal from the end semester examination– A student may for any valid reason, on production of valid proof/certificate and with the approval of the HoD be permitted to withdraw from appearing for the end semester examination (assessment 4), only if the application is made before the commencement of the examination. The student can then, appear for the Re assessment.
Re assessment– The Re assessment will be conducted during the initial phase of the consecutive semester.

Eligibility to appear for the Re assessment are:

1. Students who were absent (only with proper official permission) for Assessment 4 OR withdrawn from the Assessment 4
   weightage will be 30 % (internal marks will be used)
2. Students who failed in the subject AND who were absent (without permission) for Assessment 4
   weightage will be 100 %

Students who fail in the Re Assessment have to register for the Formative Assessment.

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

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

ACADEMIC DISHONESTY & PLAGIARISM

- Copying from other students or other sources during an assessment will be treated as punishable dishonesty. For assignment and presentation, the content which has plagiarism above 50 % would be given zero mark.
- The departmental disciplinary committee including the faculty member of the course, PAC chairperson and the HoD, as members shall verify the facts of the malpractice if the student is found guilty; the report shall be submitted to the Academic office for award of the punishment.

ADDITIONAL INFORMATION, IF ANY

Essential Reading Students can learn the course from any standard book or opensource material.

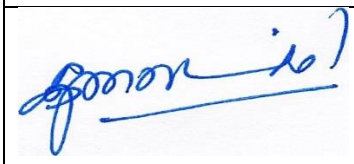
Books prescribed in the syllabus are:

Text Books:
1. Hespanha, J.P., Linear Systems Theory, Princeton Univ. Press, 2009.
2. Brogan, W.L., Modern Control Theory, 3rd edition, Prentice Hall, 1990.

Reference Books:
1. Sontag, E.D., Mathematical Control Theory, 2nd edition, Springer Verlag, 2014.
2. Hinrichsen, D., & Pritchard, A.J., Mathematical System Theory – I, Springer, 2010.

Additional Reference Books:
1. Dorf, R.C., & Bishop, R.H., Modern Control Systems, 13th edition, Prentice Hall, 2016.
3. Nise, N.S., Control Systems Engineering, 7th edition, Wiley, 2015.
4. Katsuhiko Ogata, Modern Control Engineering, PHI Learning Private Ltd, 5th Edition, 2010.

FOR APPROVAL



Course Faculty | **CC- Chairperson** | **HoD**

26.10.2020

Date: 15 Sept. 2020

Guidelines

a) The number of assessments for any theory course shall range from 4 to 6.

b) Every theory course shall have a final assessment on the entire syllabus with at least 30% weightage.

c) One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered.

d) The passing minimum shall be as per the regulations.

B.Tech. Admitted in				P.G.
2018	2017	2016	2015	
35% or (Class average/2) whichever is greater.		(Peak/3) or (Class Average/2) whichever is lower		40%

e) Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.

f) Absolute grading policy shall be incorporated if the number of students per course is less than 10.

g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.