

## VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E: Electronics & Communication Engineering / B.E: Electronics & Telecommunication Engineering  
 NEP, Outcome Based Education (OBE) and Choice Based Credit System (CBCS)  
 (Effective from the academic year 2023 - 24)

## IV Semester

Control Systems			
Course Code	BEC403	CIE Marks	50
Teaching Hours/Week (L: T: P)	(3:0:2)	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
<b>Course objectives: This course will enable students to:</b> <ol style="list-style-type: none"> <li>1. Understand basics of control systems and design mathematical models using block diagram reduction, SFG, etc.</li> <li>2. Understand Time domain and Frequency domain analysis.</li> <li>3. Analyze the stability of a system from the transfer function</li> <li>4. Familiarize with the State Space Model of the system.</li> </ol>			
<b>Teaching-Learning Process (General Instructions)</b> These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes. <ul style="list-style-type: none"> <li>• Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.</li> <li>• Show Video/animation films to explain the different concepts of Linear Algebra &amp; Signal Processing.</li> <li>• Encourage collaborative (Group) Learning in the class.</li> <li>• Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.</li> <li>• Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.</li> <li>• Topics will be introduced in a multiple representation.</li> <li>• Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.</li> <li>• Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.</li> <li>• Adopt Flipped class technique by sharing the materials / Sample Videos prior to the class and have discussions on the that topic in the succeeding classes.</li> <li>• Give Programming Assignments.</li> </ul>			
<b>Module-1</b>			
<b>Introduction to Control Systems:</b> Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems -Mechanical Systems, Electrical Systems, Analogous Systems. (Textbook 1: Chapter 1.1, 2.2)			
<b>Teaching-Learning Process</b>	Chalk and Talk, YouTube videos <b>RBT Level: L1, L2, L3</b>		



Module-2	
<b>Block diagrams and signal flow graphs:</b> Transfer functions, Block diagram algebra and Signal Flow graphs. (Textbook 1: Chapter 2.4, 2.5, 2.6)	
<b>Teaching-Learning Process</b>	Chalk and Talk, YouTube videos, Any software tool to implement block diagram reduction techniques and Signal Flow graphs <b>RBT Level:</b> L1, L2, L3
Module-3	
<b>Time Response of feedback control systems:</b> Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design). (Textbook 1: Chapter 5.3, 5.4, 5.5)	
<b>Teaching-Learning Process</b>	Chalk and Talk, YouTube videos, Any software tool to show time response for various transfer functions and PI, PD and PID controllers. <b>RBT Level:</b> L1, L2, L3
Module-4	
<b>Stability analysis:</b> Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion. <b>Introduction to Root-Locus Techniques,</b> The root locus concepts, Construction of root loci. (Textbook 1: Chapter 6.1, 6.2, 6.4, 6.5, 7.1, 7.2, 7.3)	
<b>Teaching-Learning Process</b>	Chalk and Talk, YouTube videos, Any software tool to plot Root locus for various transfer functions <b>RBT Level:</b> L1, L2, L3
Module-5	
<b>Frequency domain analysis and stability:</b> Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function. (Textbook 1: Chapter 4: 8.1, 8.2, 8.4) Mathematical preliminaries, Nyquist Stability criterion, (Stability criteria related to polar plots are excluded) (Textbook 1: 9.2, 9.3) <b>State Variable Analysis:</b> Introduction to state variable analysis: Concepts of state, state variable and state models. State model for Linear continuous –Time systems, solution of state equations. (Textbook 1: 12.2, 12.3, 12.6)	
<b>Teaching-Learning Process</b>	Chalk and Talk, YouTube videos, Any software tool to draw Bode plot for various transfer functions <b>RBT Level:</b> L1, L2, L3

### PRACTICAL COMPONENT OF IPCC

Using suitable simulation software (P-Spice/ MATLAB / Python / Scilab / OCTAVE / LabVIEW) demonstrate the operation of the following circuits:

Sl.No	Experiments
1	Implement Block diagram reduction technique to obtain transfer function a control system.
2	Implement Signal Flow graph to obtain transfer function a control system.
3	Simulation of poles and zeros of a transfer function.
4	Implement time response specification of a second order Under damped System, for different damping factors.
5	Implement frequency response of a second order System.
6	Implement frequency response of a lead lag compensator.
7	Analyze the stability of the given system using Routh stability criterion.
8	Analyze the stability of the given system using Root locus.
9	Analyze the stability of the given system using Bode plots.
10	Analyze the stability of the given system using Nyquist plot.
11	Obtain the time response from state model of a system



## Course Outcomes

At the end of the course the student will be able to:

1. Deduce transfer function of a given physical system, from differential equation representation or Block Diagram representation and SFG representation.
2. Calculate time response specifications and analyse the stability of the system.
3. Draw and analyse the effect of gain on system behaviour using root loci.
4. Perform frequency response Analysis and find the stability of the system.
5. Represent State model of the system and find the time response of the system.

### Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

### CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5<sup>th</sup> week of the semester
- Second test at the end of the 10<sup>th</sup> week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4<sup>th</sup> week of the semester
- Second assignment at the end of 9<sup>th</sup> week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

### CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test (**duration 03 hours**) at the end of the 15<sup>th</sup> week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.



**SEE for IPCC**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

**The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component.**

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.

SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured out of 100 shall be reduced proportionally to 50.

**Suggested Learning Resources:****Text Books**

1. Control Systems Engineering, I J Nagrath, M. Gopal, New age international Publishers, Fifth edition.

**Web links and Video Lectures (e-Resources):**

- <https://nptel.ac.in/courses/108106098>

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

*Programming Assignments / Mini Projects can be given to improve programming skills*

*Datta*

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