DARBHANGA COLLEGE OF ENGINEERING

DARBHANGA

Course File

INSTRUMENTATION AND CONTROL

(SEM-IV:ME)

Course Code- PCC-ME 207

Faculty Name:

Mr. Akhil Mohammed K K

Assistant Professor

ELECTRICAL & ELECTRONICS ENGINEERING

CONTENTS

Vision of the Institute

To produce young, dynamic, motivated and globally competent Engineering graduates with an aptitude for leadership and research, to face the challenges of modernization and globalization, who will be instrumental in societal development.

Mission of the Institute

1. To impart quality technical education, according to the need of the society.

2. To help the graduates to implement their acquired Engineering knowledge for society & community development.

3. To strengthen nation building through producing dedicated, disciplined, intellectual & motivated engineering graduates.

4. To expose our graduates to industries, campus connect programs & research institutions to enhance their career opportunities.

5. To encourage critical thinking and creativity through various academic programs.

Vision of the Department

To produce comprehensively trained, socially responsible, innovative electrical & electronics engineers and researchers of the highest quality to contribute to the nation’s imprint on the world stage.

Mission of the Department

1. To provide world class teaching and mentoring to the students.

2. To create Engineering graduates well equipped with the skills of relevant simulation softwares required in the field of electrical and electronics engineering.

3. To motivate graduates towards innovations and research in the field of electrical & electronics engineering, relevant to the welfare of the society.

4. To create graduates well prepared to modern and global industry requirements.

5. To expose our graduates to the latest technology and research through industry and research institutes collaborations.

PSO 1. An ability to identify, formulate and solve problems in the areas of Electrical and Electronics Engineering.

PSO 2. An ability to use the techniques, skills and modern engineering tools necessary for innovation.

PEO 1. Graduates will excel in professional careers and/or higher education by acquiring knowledge in Mathematics, Science, Engineering principles and Computational skills.

PEO 2. Graduates will analyze real life problems, design Electrical systems appropriate to the requirement that are technically sound, economically feasible and socially acceptable.

PEO 3. Graduates will exhibit professionalism, ethical attitude, communication skills, team work in their profession, adapt to current trends by engaging in lifelong learning and participate in Research & Development.

Program Educational Objectives

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Program Outcomes of B.Tech in Electrical and Electronics Engineering

1.Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2.Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3.Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4.Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5.Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6.The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7.Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need

for sustainable development.

8.Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9.Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10.Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and

write effective reports and design documentation, make effective presentations, and give and

receive clear instructions.

11.Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and

leader in a team, to manage projects and in multidisciplinary environments.

12.Life-long learning: Recognize the need and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Description

This course is design to impart the basic and theoretical concept in the field of Instrumentation and control for various process control applications. Objectives: 1. To provide a basic knowledge about measurement systems and their components 2. To learn about various sensors used for measurement of mechanical quantities 3. To learn about system stability and control 4. To integrate the measurement systems with the process for process monitoring and control

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Course Outcomes

CO1: Identify basic functional elements of any measurement system and Classify measurement system based on various factors
CO2: Analyze sensors used in measurement system using mathematical tools
CO3: Apply sensors and measurement systems in setting up of control systems for various processes
CO4: Design various control techniques to integrate the measurement systems with the process for process monitoring and control

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CO-PO MAPPING

Sr. No.	Course Outcome	PO
1.	CO1: Identify basic functional elements of any measurement system and Classify measurement system based on various factors	PO1, PO4
2.	CO2: Analyze sensors used in measurement system using mathematical tools	PO1, PO6, PO10
3.	CO3: Apply sensors and measurement systems in setting up of control systems for various processes	PO2, PO6, PO8
4.	CO4: Design various control techniques to integrate the measurement systems with the process for process monitoring and control	PO2, PO4, PO11

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Identify basic functional elements of any measurement system and Classify measurement system based on various factors	√			√								
CO2: Analyze sensors used in measurement system using mathematical tools	√					√				√		
CO3: Apply sensors and measurement systems in setting up of control systems for various processes		√				√		√				
CO4: Design various control techniques to integrate the measurement systems with the process for process monitoring and control		√		√							√	

Syllabus

Instrumentation and Control

Course Code- PCC-ME 207

1. Objectives:

1. To provide a basic knowledge about measurement systems and their components
2. To learn about various sensors used for measurement of mechanical quantities
3. To learn about system stability and control
4. To integrate the measurement systems with the process for process monitoring andcontrol

Module: 1 (10 lectures)

Measurement systems and performance -configuration of a measuring system, Methods for correction for interfering and modifying inputs– accuracy, range, resolution, error sources, precision, error sensitivity etc.Classification of errors and statistical analysis of experimental data.

Module: 2 (8 lectures)

Instrumentation system elements -sensors for common engineering measurements. Transducers based on variable resistance, variable induction, variable capacitance and piezo-electric effects, Displacement transducer.

Module: 3 (6 lectures) Signal processing and conditioning; correction elements-actuators: pneumatic, hydraulic, electric.

Module:4 (10 lectures)

Control systems – basic elements, open/closed loop, design of block diagram; control method – P, PI, PID, when to choose what, tuning of controllers.

Module:5 (6 lectures)

System models, transfer function and system response, frequency response; Nyquist diagrams and their use. Practical group based project utilizing above concepts.

Text Books:

1. Instrumentation and control systems by W. Bolton, 2nd edition, Newnes, 2000

2. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V, Mechanical Measurements (6th Edition) 6th Edition, Pearson Education India, 2007

3. Gregory K. McMillan, Process/Industrial Instruments and Controls Handbook, Fifth Edition, McGraw-Hill: New York,1999

Institute / College Name :	Darbhanga College of Engineering		
Program Name	**BTECH Mechanical**		
Course Code	PCC-ME 207		
Course Name	INSTRUMENTATION AND CONTROL		
Lecture / Tutorial (per week):	3/1	**Course Credits**	4
Course Coordinator Name	AKHIL MOHAMMED K K		

1. Scope and Objectives of the Course

This course is design to impart the basic and theoretical concept in the field of Instrumentation and control for various process control applications. Objectives: 1. To provide a basic knowledge about measurement systems and their components 2. To learn about various sensors used for measurement of mechanical quantities 3. To learn about system stability and control 4. To integrate the measurement systems with the process for process monitoring and control

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Other readings and relevant websites

S.No.	**Link of Journals, Magazines, websites and Research Papers**
1.	http://nptel.ac.in/courses/112106138/

2. Course Plan

Lecture Number	**Date of Lecture**	**Topics**	**Web Links for video lectures**	**Text Book / Reference Book / Other reading**	**Page numbers of**

				material	Text Book(s)
1-3		**Introduction**	http://nptel.ac.in/courses/112106138/	TB1,	1-11
		Functional elements of a basic measuring system,			
Tutorial – 1, Assignment I					
4-6		**Configuration of a measuring system**	http://nptel.ac.in/courses/112106138/	TB1,	11-20
		Methods for correction for interfering and modifying inputs			
Tutorial – 2, Assignment II					
7-9		**Static characteristics -**	http://nptel.ac.in/courses/112106138/	TB1,	46-69
		Accuracy, precision Error sensitivity, Dynamic characteristics terms,			
Tutorial - 3					
10-12		**Concepts of mechanical loading and time response**	http://nptel.ac.in/courses/112106138/	TB1,	70-140
		Order of the systems, Response of zero, First and second order systems to step, ramp and sinusoidal inputs, transfer function			

		method			
Tutorial – 4, Assignment 2					
13-16		**Classification of errors**	http://nptel.ac.in/courses/112106138/	TB1,	141-202
		Statistical analysis of experimental data			
Tutorial - 5					
17-20		**Description of various types of transduction principles**,		TB1,	141-202
		transducers based on variable resistance,			
Tutorial 6					
21-23		variable induction transducer,		TB1,	
		Variable capacitance transducer			
Tutorial - 7					
24-26		Piezo-electric effects		TB1,	
		Displacement transducer			
Tutorial - 8					
27-29		Signal processing and conditioning; correction elements-		TB1,	

30-32		actuators: pneumatic, hydraulic, electric.			
		Module:4 (10 lectures)			
Tutorial -9					
33-34		Control systems – basic elements, open/closed loop, design of block diagram.		TB1,	
		control method – P, PI, PID, when to choose what, tuning of controllers			
Tutorial -10					
35-36		System models, transfer function and system response, frequency response		TB1	
		Nyquist diagrams and their use.			
Tutorial – 8, Assignment 3					

1. **Evaluation Scheme:**

Component 1	Mid Semester Exam	20
Component 2	Assignment, Class tests, Attendance	10
Component 3**	End Term Examination**	70
	Total	**100**

****** The End Term Comprehensive examination will be held at the end of semester. The mandatory requirement of 75% attendance in all theory classes is to be met for being eligible to appear in this component.

SYLLABUS

Topics	No of lectures	Weightage
Module: 1 (10 lectures)		
Measurement systems and performance -configuration of a measuring system, Methods for correction for interfering and modifying inputs– accuracy, range, resolution, error sources, precision, error sensitivity etc.Classification of errors and statistical analysis of experimental data.	10	30%
Module: 2 (8 lectures)		
Instrumentation system elements -sensors for common engineering measurements. Transducers based on variable resistance, variable induction, variable capacitance and piezo-electric effects, Displacement transducer.	8	24%
Module: 3 (6 lectures) Signal processing and conditioning; correction elements- actuators: pneumatic, hydraulic, electric.	6	16%
Module:4 (10 lectures)		
Control systems – basic elements, open/closed loop, design of block diagram; control method – P, PI, PID, when to choose what, tuning of controllers.	10	30%

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Akhil Mohammed k k	
H.O.D	Mr.Prabhat Kumar	
Principal	Dr. Achintya	
Date		

Evaluation and Examination Blue Print:

Internal assessment is done through quiz tests, presentations, assignments and project work. Two sets of question papers are asked from each faculty and out of these two, without the knowledge of faculty, one question paper is chosen for the concerned examination. Examination rules and regulations are uploaded on

the student's portal. Evaluation is a very transparent process and the answer sheets of sessional tests, internal assessment assignments are returned back to the students.

The components of evaluations alongwith their weightage followed by the University is given below

Sessional Test 1	15%
Sessional Test 2	15%
Sessional Test 3	15%
Assignments/Quiz Tests/Seminars	10%
End term examination	70%

(From amongst the three sessional tests best of two are considered)

DARBHANGA COLLEGE OF ENGINEERING, DARBHANGA

ME DEPARTMENT,FOURTH SEMESTER

INSTRUMENTATION AND CONTROL

ASSIGNMENT QUESTIONS

1. **If a system has a gain of 5, what will be the output for an input voltage of 2 V?**

2. **An open-loop system consists of three elements in series, the elements having gains of 2, 5 and 10. What is the overall gain of the system?**

3. **A closed-loop control system has a forward loop with a gain of 6 and a feedback loop with a gain of 2. What will be the overall steady-state gain of the system if the feedback is (a) positive, (b) negative?**

4. **Determine the delay time and the rise time for the following firstorder systems: (a) G{s) = 1/(4s + 1)**

5. **Determine the natural angular frequency, the damping factor, the rise time, percentage overshoot and 2% settling time for a system where the output y is related to the input x by the differential equation:**

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 16y = 16x$$

ASSIGNMENT 2

6. **State if the following systems are stable, the relationship between input X and output y being described by the differential equations**

$$\text{(a) } \frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = x, \text{ (b) } \frac{d^2y}{dt^2} + \frac{dy}{dt} - 6y = x$$

7. **Describe frequency response of a system.Determine the magnitude and the phase of the response of a system with transfer function 3/(s + 2) to sinusoidal inputs of angular frequency (a) 1 rad/s, (b) 2 rad/s**

8. **..What are the frequency response functions for systems with transfer functions (a) l/(s + 5), (b) 1/(s + 2), (c) l/[(s + I0)(s + 2)J?**

9. **What are Bode plots?.Determine the asymptote Bode plot for the system having the transfer function:**

$$G(s) = \frac{50(s+2)}{s(s+10)}$$

10. **Explain Nyquist plot.How it can be used to determine stability of a system.Determine the gain margin and the phase margin for a system having an open-loop transfer function of**

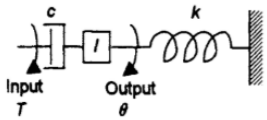
$$\frac{K}{s(s+1)(s+2)}$$

when $K = 4$.

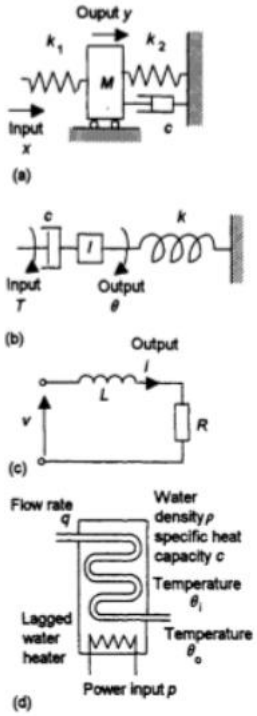
ASSIGNMENT 3

11.A closed-loop negative feedback system for the control of the height of liquid in a tank by pumping liquid from a reservoir tank can be considered to be a system with a differential amplifier having a transfer function of 5, its output operating a pump with a transfer function 5/(s + 1). The coupled system of tanks has a transfer function, relating height in the tank to the output from the pump, of 3/(s + 1)(s + 2). The feedback sensor of the height level in the tank has a transfer function of 0.1. Determine the overall transfer function of the system, relating the input voltage signal to the system to the height of liquid in the tank.

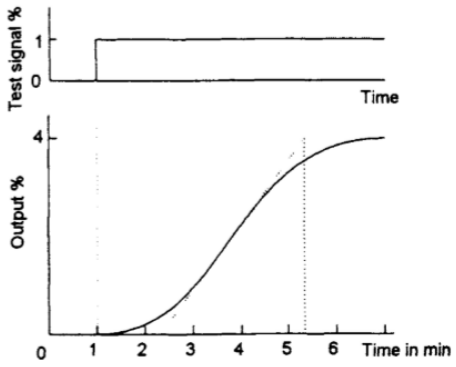
12.For a rotational system, the output theta is related to the input T.For the system to be critically damped, what is the realtion between *c*,*I* and *k*



14.Derive a differential equation relating the input and output for each of the systems shown in the following figures.



15. Write down the steps involved in the Ziegler-Nichols method for tuning PID controllers.Figure below shows the open-loop response of a system to a unit step in controller output. Using the Ziegler-Nichols data, determine the optimum settings of the PID controller to be used in the system to give good performance.



QUESTION BANK

16. Figure below shows a control system designed to control the level of water in the container to a constant level. It uses a proportional controller with Kp equal to 10. The valve gives a flow rate of 10 m^3/hr per percent of controller output, its flow rate being proportional to the controller input. If the controller output is initially set to 50% what will be the outflow from the container? If the outflow increases to 600 m^3/h, what will be the new controller output to maintain the water level constant?

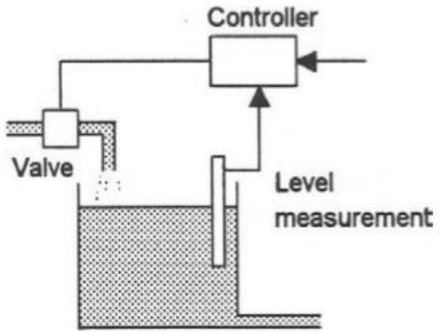


Fig.Proportional controller for water level control

17. A temperature control system has a set point of 20°C and the measured value is 18°C. What is (a) the absolute deviation, (b) the percentage deviation?

18. What is the controller gain of a temperature controller with a 80% PB if its input range is 40°C to 90° and its output is 4 mA to 20 mA?

19. Using the Ziegler-Nichols ultimate cycle method for the determination of the optimum settings of a PID controller, oscillations began with a gain of 2.2 with a period of 12 min. What would be the optimum settings for the PID controller?

20. Sketch graphs showing how the controller output will vary with time for

the error signal shown in Figure 5.34 when the controller is set initially at 50% and operates as (a) just proportional with a Kp = 5, (b) proportional plus derivative with Kp = 5 and Kd = 1.0 s, (c) proportional plus integral with Kp = 5 and Ki= 0.5 /s.

21.The cross-sectional area A of 3, wire is to be determined from a measurement of the diameter d, being given by A =$\frac{1}{4}\pi d^2$ The diameter is measured as 2.5 ± 0.1 mm. What will be the error in the area?

22. List and explain the functional elements of a measurement system

2. If a system has a gain of 5, what will be the output for an input voltage of 2 V?

2.An open-loop system consists of three elements in series, the elements having gains of 2, 5 and 10. What is the overall gain of the system?

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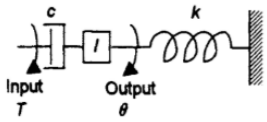

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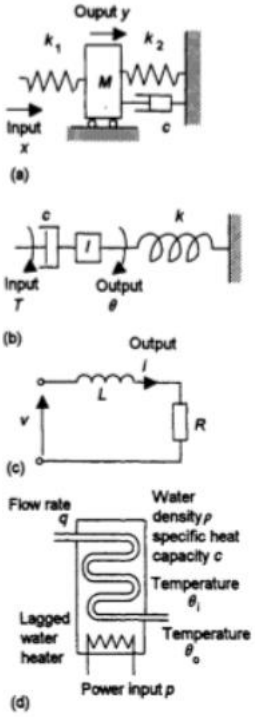

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