MUZAFFARPUR INSTITUTE OF TECHNOLOGY

MUZAFFARPUR

COURSE FILE

OF

INTELLIGENT INSTRUMENTS

(041606)

Faculty Name:

SAKET KUMAR

ASSISTANT PROFESSOR, DEPARTMENT OF ECE

CONTENTS

Department of Electronics and Communication engineering

Vision

Electronics and Communication Engineering Department goals to offer a platform of excellence to yield ingenious technocrats those can face the challenges of a new era and excel at a national level. So as to boost world-wide affluence by nurturing technology international.

Mission

M1. To offer its students with information required for superiority engineering course.

M2. To offer originality, enlargement actions, incorporation, allocation and spread over information about electronics and communication technologies.

M3. To prepare its students with a comprehensive knowledgeable spectrum with the purpose of get ready them for competitive carrier paths.

M4. Offer moral and value based education by encouraging actions addressing the collective requirements.

Electronics and Communication Engineering Program Educational Objectives

PEO-1

To graduate student for a successful profession with team work skills, effective communication skills and graft with ethics that support the diversified needs of research, industry and academia.

PEO-2

To endorse responsiveness among student towards problems of social significance and present them to proficient ethics and practice.

PEO-3

To prepare student graduates with self-learning capability by instructing the attitude to constantly learn, invent and contribute to formation of novel knowledge for the assistance of the humanity.

PEO-4

To make students in understanding, investigating and making new technologies and product that help to find solution of real world difficulties.

PEO-5

To introduce in student the aptitude to get multidisciplinary information through self-make projects and engineering training, so long as a supportable economical edge in research and development and providing industry demands.

PEO-6

To introduce in student, the potentials of management for expertise invention and entrepreneurship

Electronics and Communication Engineering Student Outcomes

Students who complete the B.Tech.degree in Electronics and Communication Engineering will be able to:

PO1 Apply the knowledge of Mathematics, Science & Engineering principles and domain specialization to solve the problems of Electronics and communication engineering in core and allied industries/institutions. (Engineering knowledge)

PO2 Identify, formulate, survey literature and analyze complex Electronics and communication engineering problems and arrive at suitable conclusions. (Problem analysis)

PO3 Design / Develop solutions for complex Electronics and communication engineering problems with due consideration for public health & safety, cultural, societal and environmental concerns.(Design/Development of solutions)

PO4 Conduct investigations on complex Electronics and communication engineering problems using various research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide suitable conclusions. (Conduct investigations of complex problems)

PO5 Use suitable techniques, resources and modern engineering tools in modeling, simulating and analyzing complex Electronics and communication engineering problems with the knowledge of their limitations. (Modern tool usage)

PO6 Apply reasoning with the appropriate knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Electronics and communication engineering practices.(The engineer and society)

PO7 Understand the impact of Electronics and communication engineering solutions on society and Eco-friendly environment and the need for sustainable development. (Environment and sustainability)

PO8 Follow professional ethics and commit to responsibilities & norms of the engineering practice (Ethics)

PO9 Contribute effectively as an individual or as a member / leader of intra- & inter-disciplinary and multi-cultural teams / working environment. (Individual and team work)

PO10 Communicate effectively both in verbal and written forms with engineers/technocrats in particular and with society at large and give/receive clear instructions.(Communication)

PO11 Apply the principles of engineering and management as a member or leader to manage Projects in multidisciplinary environment. (Project management and finance)

PO12 Recognize the necessity and pursue independent and life-long learning to keep abreast of Latest techniques. (Life-long learning)

Course description and Objectives

This course is designed to review the fundamentals and practices of to acquire the basic knowledge of Intelligent Instruments, operational amplifier, linear , non-linear application of OP-AMP, basic concept of sensor & transducer and smart sensor. It covers design and analysis active filters, PLL, A/D & D/A convector and its use To prepare students to perform the analysis and design of various linear integrated circuits.

Course Outcomes

CO315.1 Have a thorough understanding of the fundamental concepts of intelligent instruments and its characteristics.
CO315.2 To design the basic circuits using op-amp and perform operations and their troubleshooting.
CO315.3 To Understand the basic building blocks of smart sensor and interfacing devices.
CO315.4 To understand and analyze basic building blocks of different types A/D and D/A converters.
CO315.5 To understand and the basics of memory and timer circuits.

CO-PO MAPPING

Sr. No.	Course Outcome	PO
1.	CO315.1 Have a thorough understanding of the fundamental concepts of intelligent instruments and its characteristics.	1,2
2.	CO315.2 To design the basic circuits using op-amp and perform operations and their troubleshooting.	1,2,3,4,5,6,12
3.	CO315.3 To Understand the basic building blocks of smart sensor and interfacing devices.	1,2,5,6,12
4.	CO315.4 To understand, analyze and design basic building blocks of different types A/D and D/A converters.	1,2,3,5,6,12
5.	CO315.5 To understand and the basics of memory and timer circuits.	1,2,5,12

Course Outcomes	PO 1	PO 2	PO3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO315.1 Have a thorough understanding of the fundamental concepts of intelligent instruments and its characteristics.	√	√										
CO315.2 To design the basic circuits using op-amp and perform operations and their troubleshooting.	√	√	√	√	√	√						√
CO315.3 To Understand the basic building blocks of smart sensor and interfacing devices.	√	√			√	√						√
CO315.4 To understand and analyze basic building blocks of different types A/D and D/A converters.	√	√	√		√	√						√
CO315.5 To understand and the basics of memory and timer circuits	√	√			√							√

B. Tech. VI Semester (ECE)

ECE-041606 **Intelligent Instruments**

L T P/D Total	Max Marks: 100
L-T-P :	
4-1-2	Final Exam: 70 Marks
	Sessional: 20 Marks
	Internals: 10 Marks.

INTELLIGENT INSTRUMENTATION

L-T-P: 3-0-3 Credit : 5
Theory :

1. Intelligence, features characterizing intelligence, intelligent instrumentation system: features of intelligent instrumentation, components of intelligent instrumentation, block diagram of intelligent instrumentation. Lecture : 6

2. 2. Signal amplification & attenuation (OP-AMP based), instrumentation amplifier (circuit diagram, high CMRR & other features), signal linearization(different types such as diode resistor combination, OP-AMP based etc.), bias removal signal filtering (output from ideal filters, output from constant – k filters, matching of filter sections, active analog filters).
Lecture : 10

3. 3. OP-AMP based voltage to current converter, current to voltage conversion, signal integration, voltage follower (pre amplifier), voltage comparator, phase locked loop, signal addition, signal multiplication, signal transmission, description of spike filter. Lecture : 8

4. Smart sensors : Primary sensors, excitation, compensation, information coding/processing, data compensation, standard for smart sensor interface. Lecture 10

5. Interfacing instruments and computers : basic issues of interfacing, address decoding, data transfer control, A/D convertor, D/A convertors, sample & hold circuit, other interface considerations. Lecture : 8

Text Books : 1. Principles of measurements and instrumentation by Alan S Morris, PHI

2. Intelligent instrumentation by Bamay, G.C.Prentice Hall

Reference Books : 1. Sensors and transducers by Parranabis, PHI

2. Introduction to digital signal processing: MGH

Intelligent Instrument

GATE SYLLABUS

Simple op-amp circuits; Active filters

Time table: Intelligent Instrument, 6TH Sem.

Room No. EB – 2

Day/ time	09:00-10.00	10:00-11:00	11:00-12:00	12:00-1:00	1:00-2:00	2:00-3:00	3:00-4:00	4:00-5:00
MON					**B**			
TUE	II				**R**	**II-LAB**		
WED			II		**E**			
THU			II			**II-LAB**		
FRI					**A**			
SAT					**K**			

NAME LIST OF B. TECH. 2015 BATCH

ELECTRICAL BRANCH

SL. NO.	ROLL NO.	AKU REG. NO.	NAME
1	15E56	15103107055	KRISHNA KUMAR
2	15E25	15103107126	SUJEET KUMAR
3	15E35	15103107127	HAPPY KUMAR
4	15E45	15103107128	MAYANK KASHYAP
5	15E01	15103107129	PRASOON BALA
6	15E02	15103107130	SUMI SINGH
7	15E03	15103107131	SURYA NARAYAN SINGH
8	15E07	15103107132	VIVEK KUMAR
9	15E09	15103107133	ANKITA KUMARI SINDURIYA
10	15E10	15103107134	NIRAJ KUMAR
11	15E11	15103107135	SANDEEP KUMAR SITESH
12	15E12	15103107136	NISHANT GUPTA
13	15E13	15103107137	PRAKASH KUMAR
14	15E14	15103107138	PRADEEP KUMAR
15	15E15	15103107139	RAVI RANJAN
16	15E16	15103107140	RAVI SHANKAR SAH
17	15E17	15103107141	ALOK KUMAR
18	15E18	15103107142	RAVI KANT SINGH
19	15E23	15103107143	NAYAN PRIYA
20	15E26	15103107144	ATUL SHAKTI
21	15E27	15103107145	RAHUL KUMAR
22	15E28	15103107146	ABHISHEK KISHORE
23	15E29	15103107147	RUHI KUMARI
24	15E30	15103107148	RAJEEV KUMAR CHOUDHARY
25	15E32	15103107149	KISHAN KUMAR
26	15E33	15103107150	MANISH KUMAR

27	15E34	15103107151	AMIT KUMAR
28	15E36	15103107152	RAVI RANJAN
29	15E37	15103107153	SHASHANK SUDHANSHU
30	15E38	15103107154	NEHA GUPTA
31	15E39	15103107155	SWETA JAMUAR
32	15E40	15103107156	SURUCHI KUMARI
33	15E42	15103107157	TAHA ALAM
34	15E44	15103107159	NIKET NIRAJ
35	15E47	15103107160	ASHUTOSH SHIVAM JHA
36	15E49	15103107161	MEDHA CHAUDHARY
37	15E41	15103107162	SOURAV SRIKANT
38	15E51	15103107163	PRIYANKA SUMAN
39	15E52	15103107164	PALLAVI KUMARI
40	15E54	15103107165	SHASHI RANJAN
41	15E57	15103107166	RAJLAXMI KUMARI
42	15E59	15103107168	AJIT KUMAR
43	15E61	15103107170	NAYAN KUMAR NAYAN
44	15E63	15103107171	RAJU KUMAR
45	15E64	15103107172	PREM NARAYAN CHAUDHARY
46	15E31	15103107173	SAURAV KUMAR
47	15E04	15103107174	BINDIA RANI
48	15E06	15103107176	MADHU KUMARI
49	15E08	15103107177	KAJAL RAJ
50	15E19	15103107178	OM PRAKASH CHAUDHARY
51	15E20	15103107179	AMAN KUMAR
52	15E24	15103107180	JYOTI KUMARI
53	15E21	15103107181	MD SARFARAJ AHMAD
54	15E46	15103107182	SATISH KUMAR
55	15E48	15103107183	PAVAN KUMAR
56	15E55	15103107184	DEO
57	15E62	15103107185	SUDEEP KUMAR

58	15E50	15103107186	NAGESHWAR SHARMA
59	15E22	15103107278	AZIM ANSARI
60	15E65	15104107203	PRIYANKA KUMARI
61	15E66	15106107258	DEEPAK KUMAR SINGH
62	16(LE)E10	16103107901	GAUTAM BHARTI
63	16(LE)E06	16103107902	SHEKHAR KUMAR
64	16(LE)E01	16103107903	SHAFAQUE NAZREEN
65	16(LE)E07	16103107904	MD MOIN
66	16(LE)E03	16103107905	PRIYANKA KUMARI
67	16(LE)E02	16103107906	PAVAN KUMAR
68	16(LE)E04	16103107908	ROHAN RAJ
69	16(LE)E09	16103107909	PINTU KUMAR

COURSE HANDOUT

Institute / College Name :	MIT MUZAFFARPUR		
Program Name	**INTELLIGENT INSTRUMENTS**		
Course Code			
Course Name	**INTELLIGENT INSTRUMENTS**		
Lecture / Tutorial (per week):	3-0-3	**Course Credits**	5
Course Coordinator Name	SAKET KUMAR		

1. Scope and Objectives of the Course

This course is designed to review the fundamentals and practices of to acquire the basic knowledge of operational amplifier, linear , non-linear application of OP-AMP, basic concept of sensor & transducer and smart sensor. It covers design and analysis active filters, PLL, A/D & D/A convertor and its use To prepare students to perform the analysis and design of various linear integrated circuits..

The course outcomes are:

Understand and design the basic circuits using op-amp and perform operations and their troubleshooting

2. Textbooks

TB1: 'Linear Integrated Circuit, third edition,D.Roy Choudhary,shail B. Jain, New age international publication

TB2: Sensors and transducers by Parranabis, PHI

3. Reference Books

1. Ramakant A.Gayakwad, "Op-Amps and Linear Integrated Circuits", 4th edition, Pearson education
2. Coughlin & Driscoll, "Operational-Amplifiers and Linear Integrated Circuits", 6th edition, Pearson educatio

Other readings and relevant websites

S.No.	**Link of Journals, Magazines, websites and Research Papers**
1.	http://www.srmuniv.ac.in/sites/default/files/downloads/ec0206_linear_integrated_circuits_2013_14.pdf
2.	https://www.accessengineeringlibrary.com/browse/troubleshooting-electronic-equipment-includes-repair-and-maintenance-second-edition/c9780070483576ch09
3.	https://en.wikipedia.org/wiki/Linear_integrated_circuit
4.	http://www.sincomindia.com/linear-integrated-circuits-section-e-op-amp-applications-circuit.html

Course Plan

Sl. No.	Topic Name	Periods
1.INTRODUCTION		
1.1	Introduction and features characterizing intelligence	1
1.2	Intelligent instrumentation system: static and dynamic system	2
1.3	Components and block diagram	1
2. OP-AMP BASED CIRCUITS		
2.1	Signal amplification: Basic of opamp,Inverting and Non-inverting, adder, subtractor circuit etc..	**3**
2.2	V-I,I-V convertor, integration, Differentiator etc	2
2.3	Log and antilog amplifier, multiplier , Divider Circuit	1
2.3	Instrumentation amplifier	1
2.4	voltage comparator	2
2.5	Signal linearization(+ and *)	1
2.6	Filters: basics of pasive and active analog filter	1
2.7	Active LPF and HPF	2
2.8	Active BPF, BRF and all pass filter	2

2.9	Description of spike filter and K-filter	1
2.1	PLL: Introduction, types of pll,block diagram of pll	3
3. SMART SENSOR		
3.1	Introduction and Primary sensors, excitation	2
3.2	Compensation:	2
3.3	Data compensation	2
3.4	Information coding/processing,	1
3.5	Standard for smart sensor interface	1
4. INTERFACING INSTRUMENTS		
4.1	Introduction and : basic issues of interfacing	1
4.2	Address decoding	2
4.3	Data transfer control	1
4.4	Other interface considerations	1
4.5	Sample & hold circuit	2
4.6	A/D convertor:	2
4.7	D/A convertor:	2
	TOTAL	**42**

1. **Evaluation Scheme:**

Component 1	Mid Semester Exam	20
Component 2	Assignment Evaluation	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
Intelligence, features characterizing intelligence, intelligent instrumentation system: features of intelligent instrumentation, components of intelligent instrumentation, block diagram of intelligent instrumentation.	6	14%
Signal amplification & attenuation(OP-AMP based), instrumentation amplifier (circuit diagram, high CMRR & other features), signal	10	24%

linearization(different types such as diode resistor combination, OP-AMP based etc.), bias removal signal filtering (output from ideal filters, output from constant –k filters, matching of filter sections, active analog filters).		
OP-AMP based voltage to current converter, current to voltage conversion, signal integration, voltage follower (pre amplifier), voltage comparator, phase locked loop, signal addition, signal multiplication, signal transmission, description of spike filter.	8	19%
Smart sensors : Primary sensors, excitation, compensation, information coding/processing, data compensation, standard for smart sensor interface.	10	24%
Interfacing instruments and computers :basic issues of interfacing, address decoding, data transfer control, A/D convertor, D/A convertors, sample & hold circuit, other interface considerations.	8	19%

This Document is approved by:

Designation	**Name**	**Signature**
Course Coordinator	SAKET KUMAR	
H.O.D	Dr. RAM SAGAR SINGH	
Principal	Dr. J N JHA	
Date	20/05/07	

Govt. of Bihar

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

MUZAFFARPUR-842003

(Under the Department of Science & Technology Govt. of Bihar, Patna)

Department of Electronics and Communications
Intelligent instruments

1. Answer the following:-
   (i) Define quality factor. What is quality factor for band pass active filter..
   (ii) What are the properties of instrumentation amplifier?
   (iii) Draw the circuit diagram of an ideal and practical integrator.
   (iv) Define active filter .What are the advantages of active filter
   (v) What do you mean by signal linearization?
   (vi) Define and draw the circuit diagram of wide band reject filter.
2. Draw the circuit diagram of Schmitt trigger and explain its working. .
3. Design a second order low pass active filter with cutoff frequency 1 kHz. Given $c_1=c_2=0.0047\mu F$
4. Derive the gain expression for second order Butterworth high pass filter.
5. Draw the circuit diagram of instrumentation amplifier and derive the expression for gain.
6. Write short notes: (a) Signal multiplier (b) V to I and I to V converter.

Assignment 2

1. What do you mean by sample and hold circuit. Explain its circuit operation.
2. State and explain different components of intelligent instrumentation system.
3. What is basically the concept of smart sensors? What are the essential elements in such an unit? Show with the help of a diagram, the arrangement of these element
4. What are basic issues of interfacing instruments with computers? Write about data transfer control in detail.
5. Explain the various methods used for ADC. Explain anyone of them in detail. Also describe resolution, quantization error in ADC.

Lecture Plan

Sl. No.	Topic Name	Periods
	1.INTRODUCTION	
1.1	Introduction and features characterizing intelligence	1
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1.3	Components and block diagram	1
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2.7	Active LPF and HPF	2

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2.9	Description of spike filter and K-filter	1
2.1	PLL: Introduction, types of pll,block diagram of pll	3
3. SMART SENSOR		
3.1	Introduction and Primary sensors, excitation	2
3.2	Compensation:	2
3.3	Data compensation	2
3.4	Information coding/processing,	1
3.5	Standard for smart sensor interface	1
4. INTERFACING INSTRUMENTS		
4.1	Introduction and : basic issues of interfacing	1
4.2	Address decoding	2
4.3	Data transfer control	1
4.4	Other interface considerations	1
4.5	Sample & hold circuit	2
4.6	A/D convertor:	2
4.7	D/A convertor:	2
	TOTAL	**42**

MUZAFFARPUR INSTITUTE OF TECHNOLOGY MUZAFFARPUR

Department of Electronics and Communications
Intelligent Instruments

Assignment I

1. Answer the following:-
   (i) Define quality factor. What is quality factor for band pass active filter..
   (ii) What are the properties of instrumentation amplifier?
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   (v) What do you mean by signal linearization?
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1. What do you mean by sample and hold circuit. Explain its circuit operation.
2. State and explain different components of intelligent instrumentation system.
3. What is basically the concept of smart sensors? What are the essential elements in such an unit? Show with the help of a diagram, the arrangement of these element
4. What are basic issues of interfacing instruments with computers? Write about data transfer control in detail.
5. Explain the various methods used for ADC. Explain anyone of them in detail. Also describe resolution, quantization error in ADC.

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

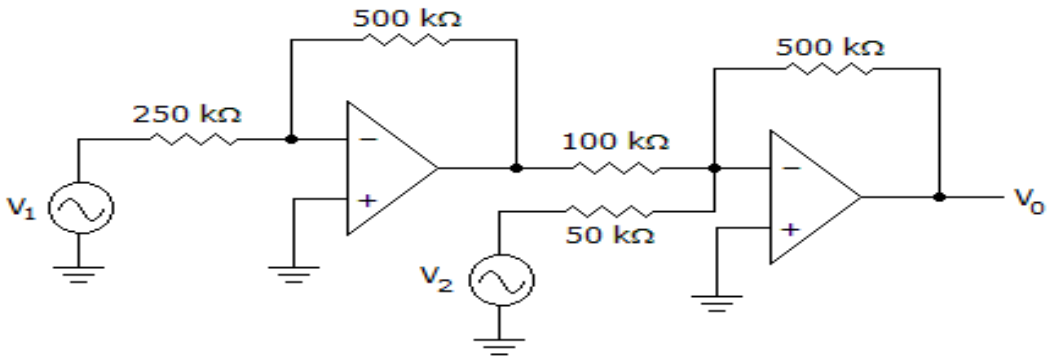
Mid-Sem Exam April'2018

Subject: Intelligent Instruments
Code:041606
Semester: VI
Branch: ECE
Time: 2 Hrs.
Full Marks: 20

1. **Answer any five** 5×1
   - I. Illustrate the ideal properties of OP-AMP?
   - II. What is CMRR? Explain with the help of expression?
   - III. What is the difference between DAC and ADC?
   - IV. Draw full wave rectifier using OP-AMP?
   - V. Explain difference amplifier using OP-AMP?
   - VI. Explain slew rate with expression?
   - VII. What is voltage follower?

Answer any five

2. Draw the block diagram of OP-AMP and explain in details? 3
3. What is instrumentation amplifier? Describe the circuit using three OP-AMP? 3
4. With the help of diagram explain various filters using OP-AMP and write down the expressions? 3
5. Calculate the output voltage V_o if V_1= -V_2= 300mv? 3



6. Differentiate between comparator and Schmitt trigger with the help of neat diagram? 3
7. Explain binary weighted ladder Digital to Analog converter? 3
8. A differential amplifier has a differential gain Ad of 100. The input voltages applied are v_1=1mv and v_2=0.9mv. Calculate the output voltage for a) CMRR=100 b) CMRR=1000 and c) CMRR=10,000. 3

QUESTION BANK

1. Answer the the following:-
   (i) Define quality factor. What is quality factor for band pass active filter.
   (ii) What are the properties of instrumentation amplifier?
   (iii) Draw the circuit diagram of an ideal and practical integrator.
   (iv) Define active filter .What are the advantages of active filter.
   (v) What do you mean by signal linearization?
   (vi) Define and draw the circuit diagram of wide band reject filter.
   (vii) What is basic difference between intelligent instrumentation system and instrumentation system?
   (viii) Why we need compensation?
2. (a) Draw the circuit diagram of Schmitt trigger and explain its working.
   (b) Describe the features of intelligent instrumentation. Give the block diagram of intelligent instrumentation system.
3. State and explain different components of intelligent instrumentation system.
4. (a) Derive the gain expression for first order butter-worth high pass filter. Draw its frequency response curve.
5. (a) Draw the circuit diagram of instrumentation amplifier and derive the expression for gain.
   (b) What do you mean by sample and hold circuit. Explain its circuit operation.
6. (a) What is basically the concept of smart sensors? What are the essential elements in such an unit? Show with the help of a diagram, the arrangement of these elements.
   (b) What is signal linearization? How you can achieve linear response by using op-amp.
7. (a) What are basic issues of interfacing instruments with computers? Write about data transfer control in detail.
   (b) Explain the various methods used for ADC. Explain anyone of them in detail. Also describe resolution, quantization error in ADC.
8. (a) What is thermistor? Describe its working and its important characteristics.
   (b) Explain the different principles of working of capacitive transducers.
9. Write short notes:
   (a) Signal multiplier (b) Piezo-electric effect.
   (c) Cubic spline interpolation method (d) Information coding/processing

(f) A high-pass RC filter acts as a pure differentiator when

(i) $\omega\tau = 0$

(ii) $\omega\tau >> 1$

(iii) $\omega\tau << 1$

(iv) $\omega\tau = 1$

where τ is the time constant and ω is the frequency.

(g) An 8-bit converter is used for a d.c. range of 0 V–10 V. Weight of LSB is

(i) 39 mV

(ii) 78 mV

(iii) 39·2 mV

(iv) None of the above

(h) Define transducer and inverse transducer. Give examples.

(i) What is the difference between accuracy and precision?

(j) Convert octal number 7654 to binary.

2. (a) What is the difference between an OPAMP and an instrumentation amplifier? Give schematic circuit. 7

(b) Mention the scheme and configuration for linearizing signal using OPAMP. 7

3. (a) Give the block diagram of intelligent instrumentation. Mention the features characterizing intelligence. 7

(b) Describe phase-locked loop with block diagram. 7

4. (a) Brief on serial and parallel interfacing and mention their advantages and disadvantages. 7

(b) Describe the operation of LAN mentioning the three basic network structures like star, bus and ring structures. 7

5. Write notes on the following : 7+7=14

(a) Primary sensors

(b) Standard for smart sensor interface

6. Write notes on the following : 7+7=14

(a) Digital encoder

(b) High-pass filter

7. Discuss autocorrelation and cross-correlation operation in signal conditioning technique. 14

Code : 041706

B.Tech 7th Semester Exam., 2015

INTELLIGENT INSTRUMENTATION

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt ***FIVE*** *questions in all.*

(iv) Question No. 1 is compulsory.

1. Choose the most appropriate answer/ Answer the following (any seven) : 2×7=14

(a) Which one of the following is an active transducer?

(i) Strain gauge

(ii) Selsyn

(iii) Photovoltaic cell

(iv) Photoemissive cell

(b) If a transducer has an output impedance of 1 Ω and a load resistance of 1 kΩ, it behaves as

(i) a constant current source

(ii) a constant voltage source

(iii) a constant impedance source

(iv) None of the above

(c) The order of the output resistance of 741 OPAMP is

(i) 0·1 Ω to 10 Ω

(ii) 10 Ω to 10^5 kΩ

(iii) 10×10^3 Ω to 10^9 Ω

(iv) 10^3 Ω to 10^6 Ω

(d) A 741 OPAMP has an open-loop gain of 200000. The input offset voltage is 2 mV. If the input terminals are shorted, output voltage is

(i) 0 V

(ii) ∞

(iii) 400 V

(iv) ± 400 V

(e) A low-pass filter has a time constant τ. Its gain at frequency ω is

(i) $\sqrt{1+(\omega\tau)^2}$

(ii) $\frac{\omega\tau}{\sqrt{1+(\omega\tau)^2}}$

(iii) $\frac{1}{\sqrt{1+(\omega\tau)^2}}$

(iv) None of the above

8. (a) Describe the operating principle of successive approximation-type analog-to-digital converter.

(b) Find the successive approximation analog-to-digital output for a 4-bit converter to an 8·217 V input if the reference is 5 V. 7

9. (a) Describe the following terms used in conjunction with D/A conversion : 7

(i) Resolution

(ii) Quantization error

(iii) Aperture time

(b) Explain the following terms in connection with an OPAMP : 7

(i) Input offset voltage

(ii) Input offset current

(iii) Slew rate

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