LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING (Autonomous)
L.B.REDDY NAGAR, MYLAVARAM-521 230. A.P. INDIA
Affiliated to JNTUK, Kakinada & Approved by AICTE, New Delhi
NAAC Accredited with "A" grade & Certified by ISO 9001:2015
DEPARTMENT OF ELECTRONICS & INSTRUMENTATION ENGINEERING
http://www.lbrce.ac.in, hodeie@lbrce.ac.in, Ph:08659-222933, Extn:408,414, Fax:08659-222931

COURSE HANDOUT

Part-A

PROGRAM **:** B.Tech., VIII-Sem., EIE

ACADEMIC YEAR **:** 2018-19

COURSE NAME & CODE **: Micro Electro Mechanical Systems- S 311**

L-T-P STRUCTURE **:** 4-1-0

COURSE CREDITS **:** 3

COURSE INSTRUCTOR **: D.VENKATA LAKSHMI**

COURSE COORDINATOR **: Dr.T.SATYANARAYANA**

PRE-REQUISITE **:** Transducers in Instrumentation & VLSI Design

COURSE EDUCATIONAL OBJECTIVES (CEOs) : This course provides knowledge about the fundamentals of Micro-Electro-Mechanical-systems& functioning of Micro scale devices. Understand the process steps in various fabrication process , etching techniques & applications.

COURSE OUTCOMES (COs): After the completion of the course, students should be able to:

CO1: Illustrate Micro sensor & Micro actuator with an example and summarize the applications of micro devices.
CO2: Apply the scaling laws to micro systems for providing information of downscaling.
CO3: Choose micro fabrication methods suited for the fabrication of a given micro system.
CO4: Analyze the static & dynamic behavior of simple micro system like Cantilever beam.
CO5: Describe the wide range of micro system applications.

COURSE ARTICULATION MATRIX (Correlation between COs& POs, PSOs):

Course Code	**COs**	**Programme Outcomes**												**PSOs**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
S311	1	2												2	
	2	3	2											2	
	3	2												3	
	4	2	3	2										3	
	5	2	2		2									3	
1 = Slightly (low) 2 = Moderate (medium) 3Substantially(High)															

BOS APPROVED TEXT BOOKS:

T1 Tai-Ran Hsu, MEMS & Microsystems Design and Manufacture, Tata McGraw Hill, 2002.

BOS APPROVED REFERENCE BOOKS:

R1Marc J.Madou , "Fundamentals of Micro Fabrication.", , CRC Press, March 12,2002.

R2Mohamed Gad-el-Hak , "The MEMS Handbook" , CRC Press, December 22,2005.

R3G.K.Anantha Suresh , "Micro and Smart Systems.", Wiley India, 2005.

Part-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I : OVERVIEW OF MEMS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction to MEMS	1	10-12-2018		1	CO1	T1	
2.	Definitions of MEMS	1	11-12-2018		1	CO1	T1	
3.	MEMS as Sensor and Actuator	1	12-12-2018		1	CO1	T1	
4.	Different types of Sensors	1	13-12-2018		1	CO1	T1	
5.	**TUTORIAL-1**	1	14-12-2018		3	CO1	T1	
6.	Actuators types & working	1	17-12-2018		1	CO1	T1	
7.	Typical Products of MEMS	1	18-12-2018		1	CO1	T1	
8.	Block diagram of Micro sensor & working principle	2	19-12-2018		1	CO1	T1	
9.	Block diagram of Micro Actuator & working principle	1	20-12-2018		1	CO1	T1	
10.	**TUTORIAL-2**	1	21-12-2018		3	CO1	T1	
11.	Benefits of Miniaturization	1	24-12-2018		1	CO1	T1	
12.	Difference between Microelectronics & Microsystems	1	26-12-2018		1	CO1	T1	
13.	Applications of MEMS in Automotive industries	1	27-12-2018		1	CO1	T1	
14.	Applications of MEMS	2	28-12-2018		1	CO1	T1	
15.	**TUTORIAL-3**	1	31-12-2018		3	CO1	T1	
16.	Materials of MEMS	2	02-01-2019		1	CO1	T1	
17.	Revision	1	03-01-2019		1	CO1	T1	
No. of classes required to complete UNIT-I		20			No. of classes taken:			

UNIT-II :SCALING LAWS IN MINIATURIZATION

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
18.	Introduction to Scaling Laws	1	04-01-2019		1	CO2	T1	
19.	Scaling in Geometry	1	07-01-2019		1	CO2	T1	
20.	**TUTORIAL-4**	1	08-01-2019		3	CO2	T1	
21.	Scaling Technology	1	09-01-2019		1	CO2	T1	
22.	Scaling in Electrostatic forces.	1	10-01-2019		1	CO2	T1	
23.	**TUTORIAL-5**	1	11-01-2019		3	CO2	T1	
24.	MEMS Design Considerations	2	17-01-2019		1	CO2	T1	
25.	Revision	1	18-01-2019		1	CO2	T1	
No. of classes required to complete UNIT-II		09			No. of classes taken:			

UNIT-III : MICRO FABRICATION-I

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
26.	Introduction, Photolithography	1	21-01-2019		1	CO3	T1	
27.	Photo resists and Application	1	22-01-2019		1	CO3	T1	
28.	Light Sources& photo resist	1	23-01-2019		1	CO3	T1	
29.	**TUTORIAL-6**	1	24-01-2019		3	CO3	T1	
30.	Ion Implantation	1	25-01-2019		1	CO3	T1	
31.	Diffusion Process	1	31-01-2019		1	CO3	T1	
32.	Oxidation process	1	01-02-2019		1	CO3	T1	
33.	**TUTORIAL-7**	1	04-02-2019		3	CO3	T1	
34.	Chemical Vapor Deposition	1	05-02-2019		1	CO3	T1	
35.	Sputtering	1	06-02-2019		1	CO3	T1	
36.	Epitaxial deposition	1	07-02-2019		1	CO3	T1	
37.	**TUTORIAL-8**	1	08-02-2019		3	CO3	T1	
38.	Introduction to Etching process	1	11-02-2019		1	CO3	T1	
39.	Different Etching processes	1	12-02-2019		1	CO3	T1	
40.	REVISION	1	13-02-2019		1	CO3	T1	
No. of classes required to complete UNIT-III		15			No. of classes taken:			

UNIT-IV :MICRO FABRICATION-II

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
41.	Introduction to Bulk fabrication	1	14-02-2019		1,2	CO4	T1	
42.	Etching-Isotropic and Anisotropic	1	15-02-2019		1	CO4	T1	
43.	Different types o Etching	2	18-02-2019		1	CO4	T1	
44.	**TUTORIAL-9**	1	19-02-2019		3	CO4	T1	
45.	Surface Micromachining	2	20-02-2019		1	CO4	T1	
46.	Associated Mechanical problems	1	21-02-2019		1	CO4	T1	
47.	LIGA process	2	22-02-2019		1	CO4	T1	
48.	**TUTORIAL-10**	1	25-02-2019		3	CO4	T1	
49.	MEMS Packaging Technologies	2	26-02-2019		1	CO4	T1	
50.	Revision	1	27-02-2019		1	CO4	T1	
No. of classes required to complete UNIT-IV		14			No. of classes taken:			

UNIT-V : MEMS DEVICES & STRUCTURES

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
51.	Introduction to Micro Sensors	1	28-02-2019		1	CO5	T1	
52.	Biomedical Sensors	1	01-03-2019		1	CO5	T1	
53.	Chemical sensors	1	04-03-2019		1	CO5	T1	
54.	**TUTORIAL 11**	1	05-03-2019		3	CO5	T1	
55.	Optical Sensors	1	06-03-2019		1	CO5	T1	
56.	Pressure Sensors & Thermal sensors	2	07-03-2019		1	CO5	T1	
57.	**TUTORIAL 12**	1	08-03-2019		3	CO5	T1	
58.	Actuation using thermal forces	1	11-03-2019		1	CO5	T1	
59.	Piezoelectric & Electrostatic forces	1	12-03-2019		1	CO5	T1	
60.	Introduction to Micro actuators	1	13-03-2019		1	CO5	T1	
61.	**TUTORIAL 13**	1	14-03-2019		3	CO5	T1	

62.	Micro grippers	1	15-03-2019		1	CO5	T1	
63.	Micro motors	1	18-03-2019		1	CO5	T1	
64.	Working principle of Micro pumps	1	19-03-2019		1	CO5	T1	
	Revision	1	20-03-2019		1	CO5	T1	
No. of classes required to complete UNIT-V	16				No. of classes taken:			

Contents beyond the Syllabus

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign
1.	Adaptive Control		21-03-2019		1,2		R1	
2.	Predictive Control		22-03-2019		1,2		R1	

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

Part - C

EVALUATION PROCESS:

Evaluation Task	**COs**	**Marks**
Assignment/Quiz – 1	1	A1=5
Assignment/Quiz – 2	2	A2=5
I-Mid Examination	1,2	B1=20
Assignment/Quiz – 3	3	A3=5
Assignment/Quiz – 4	4	A4=5
Assignment/Quiz – 5	5	A5=5
II-Mid Examination	3,4,5	B2=20
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	A=5
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	B=20
Cumulative Internal Examination : A+B	**1,2,3,4,5**	**A+B=25**
Semester End Examinations	**1,2,3,4,5**	**C=75**
Total Marks: A+B+C	**1,2,3,4,5**	**100**

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Electronics & Instrumentation engineering graduates are expected to attain the following program educational objectives (PEOs) within a period of 3-5 years after graduation. Our graduates will:

PEO1: Successfully utilize engineering and non-engineering principles for design and analysis as needed in their field.

PEO2: Become a life-long learner through the successful completion of advanced degree(s), continuing education, or other professional development.

PEO3: Exhibit effective communication, teamwork, leadership skills and ethical behaviour as per the standard practice in the workplace

PROGRAM OUTCOMES

Engineering Graduates will be able to:

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 modeling 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 for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

After completion of program, Graduates will be able to

PSO1-Acquire the ability to explore the design, installation & operation of the basic instrumentation system used in industrial environments and also calibrate the process instruments.

PSO2- Apply appropriate modern Engineering hardware and software tools like PLC, LABVIEW, MATLAB in order to implement and evaluate in process control and instrumentation system along with safety measures that enables him/her to work effectively as an individual and in a multidisciplinary team.

D.Venkata Lakshmi	Dr.T.Satyanarayana	Mr.M.Vasu Babu	Dr.B.Poornaiah
Course Instructor	Course Coordinator	Module Coordinator	HOD

COURSE HANDOUT

Part-A

PROGRAM : B.Tech., VIII-Sem., EIE

ACADEMIC YEAR : 2018-19

COURSE NAME & CODE : ESD-S229

L-T-P STRUCTURE : **4**-1-0

COURSE CREDITS : 3

COURSE INSTRUCTOR : **Mrs.G.Anusha**

COURSE COORDINATOR : **Prof.G.Mallikarjuna Rao**

Prerequisite: Microprocessors and Microcontrollers, VLSI design

Course Educational Objectives:

In this course student will learn about the basic concepts of embedded systems and real time systems

,the method of designing a real time system,implementing and testing of an embedded system, the characteristics of latency in real time systems, Summarizing the special concerns that real time systems present and how theseconcerns are addressed.

Course Outcomes:

At the end of this course student will be able to

CO1: Remember the concepts of embedded systems and real time systems

CO2: Understand the unique design problems and challenges of real time systems

CO3: Apply the general structure of embedded system

CO4: Analyze the unique characteristics of real time systems

CO5: Evaluate real time systems design techniques to various software programs.

COURSE ARTICULATION MATRIX (Correlation between COs& POs, PSOs):

Course Code	COs	Programme Outcomes												PSOs	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
S313	1	2	2	3		2	3						2		2
	2	2	2	3		1	3						2		2
	3	1	2	3		3	3						2		2
	4	1	2	3		3	3						3		2
	5	1	2	3		3	3						3		3
1 = Slightly (low) 2 = Moderate (medium) 3-Substantially(High)															

BOS APPROVED TEXT BOOKS

1. Raj Kamal, "Embedded Systems Architecture, Programming and Design", Tata McGraw Hill Publishers, 2003.

2. Frank Vahid, Tony D. Givargis "Embedded System Design: A Unified Hardware/ Software Introduction ",Wiley India Edition, 2002.

BOS APPROVED REFERENCES

1. Peter Mervedel, "Embedded Systems Design", Springer Verlag Publications,2006.

2. K.V.K.K. Prasad "Embedded / Real Time Systems", Dream tech Press, 2005.

3. Jonathan W. Valvano, "Embedded Microcomputer Systems: Real time interfacing", Thomson Engineering Publications,2006.

4. David E. Simon "An Embedded Software Primer", Pearson Edition Publications, 2005.

5. Sri Ram V Iyer, Pankaj Gupta "Embedded Real Time Systems Programming", TMH, 2004.

Part-B

COURSE DELIVERY PLAN (LESSON PLAN):

UNIT-I :Introduction to Embedded Systems

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction to Embedded systems	1	10.12.18		1	CO1	T1	
2.	Embedded systems Vs general computing system	1	11.12.18		1	CO1	T1	
3.	History of Embedded systems ,classification of Embedded systems	1	12.12.18		1	CO1	T1	
4.	Major Application areas	1	13.12.18		1	CO1	T1	
5.	Purpose of embedded systems	1	14.12.18		1,2	CO1	T1	
6.	Characteristics and quality attributes of embedded systems	1	17.12.18		1,2	CO1	T1	
7.	**Tutorial-1**	1	18.12.18		3	CO1	T1	
8.	Reset circuit,Brown-out protection circuit	1	19.12.18		1	CO1	T1	
9.	Oscillator unit	1	20.12.18		1,2	CO1	T1	
10.	Real time clock	1	21.12.18		1	CO1	T1	
11.	**Tutorial-2**	1	24.12.18		1	CO1	T1	
12.	Watch dog timer	1	26.12.18		3	CO1	T1	
13.	Embedded firmware design apporches	1	27.12.18		1	CO1	T1	
14.	Revision	1	28.12.18		1	CO1	T1	
No. of classes required to complete UNIT-I		14			No. of classes taken:			

UNIT-II :Embedded Systems Components

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
15.	General purpose and Domain specific processors	1	02.01.19		1	CO2	T1	
16.	ASICs, PLDs	1	03.01.19		1	CO2	T1	
17.		1			1	CO2	T1,R2	
18.	Commercial off- the-shelf components(COTS)	1	04.01.19		1	CO2	T1	
19.	Memory:ROM,RAM	1	07.01.19		1	CO2	T1	
20.	**Tutorial-3**	1	08.01.19		3	CO2	T1	
21.	Memory according to the type of interface	1	09.01.19		1	CO2	T1,R1	
22.	Memory shadowing	1	10.01.19		1	CO2	T1	
23.	Memory selection for Embedded systems	1	11.01.19		1	CO2	T1	
24.	Sensors	1	16.01.19		1	CO2	T1	
25.	Actuators	1	17.01.19		1	CO2	T1	
26.	**Tutorial-4**	1	18.01.19		3	CO2	T1	
27.	Communication Interfaace:Onboard external communication interfaces	1	21.01.19		1	CO2	T1	
28.	External Communication Interfaces	1	22.01.19		1	CO2	T1	
29.	Serial communication using I2C	1	23.01.19		1	CO2	T1	
30.	CAN,USB	1	24.01.19		1	CO2	T1	
31.	Parallal buses(ISA,PCI,PCI/X)	1	25.01.19		1		T1	

32.	**I MID EXAMS**	1	28.01.19					
33.	**I MID EXAMS**	1	29.01.19					
34.	**I MID EXAMS**	1	30.01.19					
No. of classes required to complete UNIT-II		17			No. of classes taken:			

UNIT-III :Device Drivers and Interrupts

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
35.	Interrupt Service routine	1	31.01.19		1	CO3	T1	
36.	Device drivers	1	01.02.19		1	CO3	T1	
37.	Parallal port device drivers	1	04.02.19		1	CO3	T1,R2	
38.	**Tutorial-5**	1	05.02.19		3	CO3	T1	
39.	Serial port device drivers	1	06.02.19		1,2	CO3	T2	
40.	Device driversfor timing devices	1	07.02.19		1	CO3	T1	
41.	Context	1	08.02.19		1	CO3	T1	
42.	Interrupt latency	1	11.02.19		1	CO3	T1	
43.	**Tutorial-6**	1	12.02.19		3	CO3	T2,R3	
44.	Dead line	1	13.02.19		1	CO3	T1	
45.	Revision	1	14.02.19		1	CO3	T1	
No. of classes required to complete UNIT-III		11			No. of classes taken:			

UNIT-IV :Inter-Process Communication

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
46.	Multiple Processes	1	15.02.19		1	CO4	T1	

47.	Tasks	1	18.02.19		1	CO4	T1	
48.	Threads	1	20.02.19		3	CO4	T2,R4	
49.	Shared memory	1	21.02.19		1	CO4	T1	
50.	**Tutorial-7**	1	22.02.19					
51.	Semaphore,message queue	1	25.02.19		1	CO4	T1	
52.	Mail box,message passing	1	26.02.19		1	CO4	T	
53.	Remote Procedure call and sockets	1	27.02.19		1	CO4	T1	
54.	Task Communication and Syncronization	1	28.02.19		1	CO4	T1	
No. of classes required to complete UNIT-IV		09			No. of classes taken:			

UNIT-V:Real Time Operating Systems

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
55.	Introduction to Operating systems	1	05.03.19		1	CO5	T1	
56.	Operating system services	1	06.03.19		1	CO5	T1	
57.	Basics of RTOS	1	07.03.19		1	CO5	T1	
58.	Embedded Operating systems	1	08.03.19		3	CO5	T1,R1	
59.	Scheduler	1	11.03.19		1	CO5	T2	
60.	**Tutorial-8**	1	12.03.19					
61.	Objects,services	1	13.03.19		1	CO5	T1	
62.	Characteristics of RTOS	1	14.03.19					
No. of classes required to complete UNIT-V		08						

Contents beyond the Syllabus

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
63.	ARM Processors	1						

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/SwayamPrabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

Part - C

EVALUATION PROCESS:

Evaluation Task	**COs**	**Marks**
Assignment/Quiz – 1	1	A1=5
Assignment/Quiz – 2	2	A2=5
I-Mid Examination	1,2	B1=20
Assignment/Quiz – 3	3	A3=5
Assignment/Quiz – 4	4	A4=5
Assignment/Quiz – 5	5	A5=5
II-Mid Examination	3,4,5	B2=20
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	A=5
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	B=20
Cumulative Internal Examination : A+B	**1,2,3,4,5**	**A+B=25**
Semester End Examinations	**1,2,3,4,5**	**C=75**
Total Marks: A+B+C	**1,2,3,4,5**	**100**

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Electronics & Instrumentation Engineering graduates are expected to attain the following program educational objectives (PEOs) within a period of 3-5 years after graduation.Ourgraduates will :

PEO1: Successfully utilize engineering and non-engineering principles for design and analysis as needed in their field

PEO2:Become a life-long learner through the successful completion of advanced degree(s), continuing education, or other professional development.

PEO3: Exhibit effective communication, teamwork, leadership skills and ethical behaviour as per the standard practice in the workplace

PROGRAM OUTCOMES

Engineering Graduates will be able to:

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

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complexengineering 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 anddesign 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 researchmethods 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 modernengineering and IT tools including prediction and modeling 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 solutionsin 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 ofthe engineering practice.

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

10. **Communication**: Communicate effectively on complex engineering activities with the engineeringcommunity 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 theenginee**ring 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 for, and have the preparation and ability to engage inindependent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

After completion of programme, Graduates will be able to

PSO1-Acquire the ability to explore the design, installation & operation of the basic instrumentation system used in industrial environments and also calibrate the process instruments..

PSO2- Apply appropriate modern Engineering hardware and software tools like PLC, LABVIEW, MATLAB in order to implement and evaluate in process control and instrumentation system along with safety measures that enables him/her to work effectively as an individual and in a multidisciplinary team.

Mrs.G.Anusha	Prof.G.M.Rao	Prof.G.M.Rao	Prof.B.Poornaiah
Course Instructor	Course Coordinator	Module Coordinator	HOD

COURSE HANDOUT

Part-A

PROGRAM : B.Tech., VIII-Sem., EIE

ACADEMIC YEAR : 2018-19

COURSE NAME & CODE : Advanced Sensors - S 107

L-T-P STRUCTURE : 4-1-0

COURSE CREDITS : 3

COURSE INSTRUCTOR : V.Vineela

COURSE COORDINATOR : Mr.R.Sarveswara Prasad

PRE-REQUISITES : Transducers in Instrumentation

COURSE EDUCATIONAL OBJECTIVES (CEOs) : This course provides the knowledge on thermal sensors for temperature measurement, Magnetic sensors, Radiation Sensors, Smart sensors, Micro Sensors and recent trends in sensor technologies

COURSE OUTCOMES (COs)

After completion of the course, the student will be able to

CO1: Apply the concepts of thermal sensors for temperature measurement.

CO2: Analyze the working principles of Magnetic sensors.

CO3: Differentiate various Radiation Sensors.

CO4: Analyze parameters related to Smart sensors & Micro Sensors.

CO5: Illustrate the recent trends in sensor technologies.

COURSE ARTICULATION MATRIX (Correlation between COs&POs,PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												2	2
CO2	2	3											2	
CO3		2												
CO4	2	3											2	
CO5											1			

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**

1- Slight (Low), **2 –** Moderate (Medium), **3 -** Substantial (High).

BOS APPROVED TEXT BOOKS:

T1 D. Patranabis, Sensors and Transducers, Wheeler Publishing, New Delhi, 1997.

BOS APPROVED REFERENCE BOOKS:

R1 S. Middle Hock and S.A. Andel, Silicon Sensors, Academic Press, London, 1989.

Part-B

COURSE DELIVERY PLAN (LESSON PLAN)

UNIT-I : Thermal Sensors

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction to Subject	1	10-12-2018		1	CO1	T1	
2.	Course Outcomes	1	11-12-2018		1	CO1	T1	
3.	Introduction to UNIT-I	1	12-12-2018		1	CO1	T1	
4.	Gas Thermometric Sensors	1	13-12-2018		1	CO1	T1	
5.	Thermal Expansion type	1	14-12-2018		1	CO1	T1	
6.	Acoustic temperature sensor	1	17-12-2018		1	CO1	T1	
7.	TUTORIAL-1	1	18-12-2018		3	CO1	T1	
8.	Dielectric constant thermo sensors	1	19-12-2018		1	CO1	T1	
9.	Refractive index thermo sensors	1	20-12-2018		1	CO1	T1	
10.	Nuclear type thermo sensors, Magnetic thermometer	1	21-12-2018		1	CO1	T1	
	Thermo					CO1	T1	

11.	sensors using semiconductor devices	1	24-12-2018		1			
12.	Junction semiconductor types	1	26-12-2018		1	CO1	T1	
13.	TUTORIAL-2	1	27-12-2018		3	CO1	T1	
14.	Junction semi conductor types	1	28-12-2018		1	CO1	T1	
15.	PTAT sensors	1	31-12-2018		1	CO1	T1	
16.	Noise thermometry, heat flux sensors	1	02-01-2019		1	CO1	T1	
17.	Quartz crystal thermoelectric sensors	1	03-01-2019		1	CO1	T1	
18.	TUTORIAL-3	1	04-01-2019		3	CO1	T1	
19.	NQR thermometry	1	07-01-2019		1	CO1	T1	
20.	Spectroscopic thermometry	1	08-01-2019		1	CO1	T1	
21.	Noise thermometry	1	09-01-2019		1	CO1	T1	
22.	Heat fluxsensors	1	10-01-2019		1	CO1	T1	
No. of classes required to complete UNIT-I		22			No. of classes taken:			

UNIT-II : Magnetic Sensors

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
23.	Introduction to ADLCs	1	11-01-2019		1	CO2	T1	
24.	Matteucci effect, Villari effect	1	14-01-2019		1	CO2	T1	
25.	Wiedemann effect, Thomson effect,	1	15-01-2019		1	CO2	T1	
26.	skin effect, Sixtus-Tanks effect	1	16-01-2019		1	CO2	T1	
27.	SQUID, Joule Effect	1	17-01-2019		1	CO2	T1	
28	TUTORIAL-4	1	18-01-2019		3	CO2	T1	
29	Types of sensors using these effects	1	21-01-2019		1	CO2	T1	
30	Yoke coil type, co-axial types,	1	22-01-2019		1	CO2	T1	
31	Force and displacement sensors, Anisotropic magneto-strictive sensing,	1	23-01-2019		1	CO2	T1	

32	Semiconductor magneto resistors, Hall effect sensor, eddy current sensor	1	24-01-2019		1	CO2	T1	
33	Switching magnetic sensors, SQUID sensors.	1	25-01-2019		1	CO2	T1	
No. of classes required to complete UNIT-II		11			No. of classes taken:			

UNIT-III : Radiation Sensors

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
34	X-ray sensors	1	31-01-2019		1	CO3	T1	
35	Nuclear radiation sensors	1	01-02-2019		1	CO3	T1	
36	Ionization chamber	1	04-02-2019		1	CO3	T1	
37	Geiger counter	1	05-02-2019		1	CO3	T1	
38	Scintillation detectors	1	06-02-2019		1	CO3	T1	
39	Solid state detectors		07-02-2019		1	CO3	T1	
40.	TUTORIAL-5	1	08-02-2019		3	CO3	T1	
41.	plastic film detectors	1	11-02-2019		1	CO3	T1	
42.	Luminescent detectors	1	12-02-2019		1	CO3	T1	
43.	Factors affecting Radiation	1	13-02-2019		1	CO3	T1	
44.	Factors affecting Measurement	1	14-02-2019		1	CO3	T1	
45.	TUTORIAL-6	1	15-02-2019		3	CO3	T1	
No. of classes required to complete UNIT-III		12			No. of classes taken:			

UNIT-IV : SMART SENSORS & MICRO SENSORS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
46.	Primary sensors	1	18-02-2019		1	CO4	T1	
47.	Excitation	1	19-02-2019		1	CO4	T1	
48.	Converters	1	20-02-2019		1	CO4	T1	
49.	Non-linearity, noise	1	21-02-2019		1	CO4	T1	
50.	Response time,	1	22-02-2019		1	CO4	T1	
51.	drift, cross sensitivity	1	25-02-2019		1	CO4	T1	
52.	Interference and their compensation	1	26-02-2019		1	CO4	T1	
53.	TUTORIAL-7	1	27-02-2019		3	CO4	T1	

54.	Information coding and data communication.	1	28-02-2019		1	CO4	T1	
55.	Thin films sensors,	1	01-03-2019		1	CO4	T1	
56.	Micro sensors for sensing thermal, radiation signals	1	04-03-2019		1	CO4	T1	
57.	Micro sensors for mechanical signals	1	05-03-2019		1	CO4	T1	
58.	TUTORIAL-8	1	06-03-2019		3	CO4	T1	
59.	Micro sensors for magnetic signals	1	07-03-2019		1	CO4	T1	
60.	Micro sensors for chemical signals	1	08-03-2019		1	CO4	T1	
No. of classes required to complete UNIT-IV		15			No. of classes taken:			

UNIT-V : RECENT TRENDS IN SENSOR TECHNOLOGIES

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
61.	Thick film sensors	1	11-03-2019		1	CO5	T1	
62.	TUTORIAL-9	1	12-03-2019		3	CO5	T1	
63.	Thin film sensors	1	13-03-2019		1	CO5	T1	
64.	Semi -conductor IC technology	1	14-03-2019		1	CO5	T1	
65.	MEMS – applications	1	15-03-2019		1	CO5	T1	
66.	Automotive sensors	1	18-03-2019		1	CO5	T1	
67.	TUTORIAL-10	1	19-03-2019		3	CO5	T1	
68.	Flow rate sensors	1	20-03-2019		1	CO5	T1	
69.	Pressure sensors	1	21-03-2019		1	CO5	T1	
70.	Temperature sensors	1	22-03-2019		1	CO5	T1	
71.	Oxygen sensors	1	25-03-2019		1	CO5	T1	
72.	TUTORIAL-11	1	26-03-2019		3	CO5	T1	
73.	Torque and position Sensors	1	27-03-2019		1	CO5	T1	
74.	Measuring air speed on aircraft	1	28-03-2019		1	CO5	T1	
75.	Sensors for Environmental monitoring,Pollution hazards.	1	29-03-2019		1	CO5	T1	
76	Sensing environmental pollution, Ecological studies of air	1	01-04-2018		1	CO5	T1	

No. of classes required to complete UNIT-V	16	No. of classes taken:

Contents beyond the Syllabus

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign
77.	Home Appliance Sensors	1	02-04-2018				T1	
78.	Sensors Manufacturing	1	03-04-2018				T1	

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

Part - C

EVALUATION PROCESS:

Evaluation Task	COs	Marks
Assignment/Quiz – 1	1	A1=5
Assignment/Quiz – 2	2	A2=5
I-Mid Examination	1,2	B1=20
Assignment/Quiz – 3	3	A3=5
Assignment/Quiz – 4	4	A4=5
Assignment/Quiz – 5	5	A5=5
II-Mid Examination	3,4,5	B2=20
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	A=5
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	B=20
Cumulative Internal Examination : A+B	**1,2,3,4,5**	**A+B=25**
Semester End Examinations	**1,2,3,4,5**	**C=75**
Total Marks: A+B+C	**1,2,3,4,5**	**100**

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Electronics & Instrumentation Engineering graduates are expected to attain the following program educational objectives (PEOs) within a period of 3-5 years after graduation.

Our graduates will be

PEO1: Successfully utilize engineering and non-engineering principles for design and analysis as needed by their field

PEO2:life-long learner through the successful completion of advanced degree(s), continuing education, or other professional development.

PEO3:Exhibit effective communication, teamwork, leadership skills and ethical behaviour as standard practice in the workplace

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

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 modeling 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 enginee**ring 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 for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1- Acquire the ability to explore the design, installation & operation of the basic instrumentation system used in industrial environments and also calibrate the process instruments..

PSO2- Apply appropriate modern Engineering hardware and software tools like PLC, LABVIEW, MATLAB in order to implement and evaluate in process control and instrumentation system along with safety measures that enables him/her to work effectively as an individual and in a multidisciplinary team.

V.Vineela	Mr.R.Sarveswara Prasad	Mr.M.Vasu Babu	Dr.B.Poornaiah
Course Instructor	Course Coordinator	Module Coordinator	HOD

LAKIREDDY BALI REDDY COLLEGE OF ENGINEERING (Autonomous)
L.B.REDDY NAGAR, MYLAVARAM-521 230.A.P. INDIA
Affiliated to JNTUK, Kakinada & Approved by AICTE, New Delhi
NAAC Accredited with "A" grade & Certified by ISO 9001:2015
DEPARTMENT OF ELECTRONICS & INSTRUMENTATION ENGINEERING
http://www.lbrce.ac.in, hodeie@lbrce.ac.in, Ph:08659-222933, Extn:408,414, Fax:08659-222931

COURSE HANDOUT

Part-A

PROGRAM : B.Tech., VIII-Sem., EIE

ACADEMIC YEAR : 2018-19

COURSE NAME & CODE : Renewable Energy Sources -

L-T-P STRUCTURE : 4-1-0

COURSE CREDITS : 3

COURSE INSTRUCTOR : Mr. G.Mahammed Rafi

COURSE COORDINATOR : Mr.S.Premkumar

PRE-REQUISITES: None

COURSE EDUCATIONAL OBJECTIVES (CEOs) : This course provides the knowledge of various Renewable energy sources , energy conversion principles, technologies and capacities for generating power.

COURSE OUTCOMES (COs)

After completion of the course, the student will be able to

CO1: Explain the potential of Renewable energy sources and solar energy Principles & applications.

CO2: Apply the principles of energy conversion to study wind and Geothermal energy plants.

CO3: Analyze the power generating capacities of wave energy and ocean thermal energy plants.

CO4: Describe the biomass production system technologies and their capacities for generating power.

CO5: Summarize different direct energy conversion principles, systems and potential for power generation.

COURSE ARTICULATION MATRIX (Correlation between COs&POs,PSOs):

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2		1		2	2					1	1	
CO2	2			2		1	2					1	2	
CO3	1	3		2		2	2					1	2	
CO4	1	1		1		1	2					1	2	
CO5	1	1		2		1	2					1	1	

Note: Enter Correlation Levels **1** or **2** or **3.** If there is no correlation, **put '-'**
1- Slight (Low), **2 –** Moderate (Medium), **3 -** Substantial (High).

BOS APPROVED TEXT BOOKS:

T1 Leslie Cromwell, Fred j. Weibell, Erich a. Pfeiffer," Bio medical instrumentation &Measurements", PHI publishers, 2nd edition,2001.

T2 John G.Webster, editor john wiley,"Medical instrumentation application & design", 3rd edition,2009.

BOS APPROVED REFERENCE BOOKS:

R1 John Twidell &Tony Weir, Renewable Energy Resources, 2nd Edition, Taylor & Francis, 2006.

R2 G.N.Tiwari, Solar Energy – Fundamentals, Design, Modelling and Applications, Narosa Publication Ltd., 2000.

Part-B

COURSE DELIVERY PLAN (LESSON PLAN)

UNIT-I :

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
1.	Introduction to Subject	1	10-12-2018		1	CO1	T1	
2.	Course Outcomes	1	11-12-2018		1	CO1	T1	
3.	Introduction to UNIT-I	1	12-12-2018		1	CO1	T1	
4.	Energy Scenario	1	13-12-2018		1	CO1	T1	
5.	Survey of Energy Resources-1	1	14-12-2018		1	CO1	T1	
6.	Survey of Energy Resources-2	1	17-12-2018		1	CO1	T1	
7.	TUTORIAL-1	1	18-12-2018		3	CO1	T1	
8.	Classification of Energy Resources	1	19-12-2018		1	CO1	R1	
9.	Need for Non-Conventional Energy Resources	1	20-12-2018		1	CO1	R1	
10.	Solar Energy-The Sun	1	21-12-2018		1	CO1	T1	
11.	Sun-Earth Relationship	1	24-12-2018		1	CO1	T1	
12.	Solar radiation-Attention –	1	26-12-2018		1	CO1	T1	
13.	Solar radiation-measuring Instruments	1	27-12-2018		1	CO1	T1	
14.	Solar water Heating, Space Heating	1	28-12-2018		1	CO1	T1	
15.	Active and Passive heating	1	31-12-2018		1	CO1	T1	
16.	TUTORIAL-2	1	02-01-2019		1	CO1	T1	
17.	Energy storage, selective surface	1	03-01-2019		3	CO1	T1	
18.	solar stills and ponds	1	04-01-2019		1	CO1	T1	
19.	solar refrigeration, photovoltaic generation.	1	07-01-2019					
No. of classes required to complete UNIT-I		19			No. of classes taken:			

UNIT-II : WIND ENERGY&GEOTHERMAL ENERGY

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
20.	Wind characteristics		08-01-2019		1	CO2	T1	
21.	Wind energy		09-01-2019		1	CO2	T1	

	conversion systems							
22.	types – Betz model – Interference Factor	1	10-01-2019		1	CO2	T1	
23.	Power Coefficient – Torque Coefficient and thrust coefficient	1	11-01-2019		1	CO2	T1	
24.	Lift machines and drag machines – matching electricity generation..	1	17-01-2019		2	CO2	T1	
25.	Structure of Earth	1	18-01-2019		1	CO2	T1	
26.	Geothermal Regions – Hot springs	1	21-01-2019		1	CO2	T1	
27.	Hot Rocks – Hot Aquifers –	1	22-01-2019		1	CO2	T1	
28.	Analytical Methods to estimate Thermal Potential	1	23-01-2019		1	CO2	T1	
29.	Harnessing Techniques – Electricity Generation Systems	1	24-01-2019		1	CO2	T1	
30.	TUTORIAL-3	1	31-01-2019		1	CO2	T1	
No. of classes required to complete UNIT-II		16			No. of classes taken:			

UNIT-III : ENERGY FROM OCEANS, WAVE ENERGY& OCEAN THERMAL ENERGY

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
31.	Tidal Energy	1	01-02-2019		1	CO3	T1	
32.	Tides	1	04-02-2019		1	CO3	T1	
33.	Diurnal Nature	1	05-02-2019		1	CO3	T1	
34.	Semi – Diurnal Nature	1	06-02-2019		1	CO3	T1	
35.	Power from Tides.	1	07-02-2019		1	CO3	T1	
36.	Waves		08-02-2019		1	CO3	T1	
37.	Theoretical Energy Available	1	11-02-2019		1	CO3	T1	
38.	TUTORIAL-4	1	12-02-2019		3	CO3	T1	
39.	Calculation of period of waves	1	13-02-2019		1	CO3	R2	
40.	Calculation of velocity of waves	1	14-02-2019		1	CO3	R2	
41.	Wave power systems	1	15-02-2019		1	CO3	R2	
42.	Submerged devices.	1	18-02-2019		1	CO3	**R2**	
43.	TUTORIAL-5	1	19-02-2019		3	CO3	T1	

44.	Ocean thermal energy: Principles	1	20-02-2019		1	CO3	T1	
45.	Heat Exchangers	1	21-02-2019		1	CO3	T1	
46.	Pumping requirements	1	22-02-2019		1	CO3	T1	
47.	Practical Considerations.	1	25-02-2019		2	CO3	T1	
No. of classes required to complete UNIT-III		13			No. of classes taken:			

UNIT-IV : BIO – ENERGY

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
48.	Biomass Energy Sources	1	26-02-2019		1	CO4	T2	
49.	Plant Productivity	1	27-02-2019		1	CO4	T2	
50.	Biomass Wastes	1	28-02-2019		1	CO4	T2	
51.	Aerobic bio-conversion processes	1	01-03-2019		1	CO4	T2	
52.	Anaerobic bio-conversion processes	1	04-03-2019		1	CO4	T2	
53.	TUTORIAL-6	1	05-03-2019		3	CO4	T2	
54.	Raw Materials	1	06-03-2019		1	CO4	R2	
55.	Properties of Bio-gas	1	07-03-2019		1	CO4	R2	
56.	Bio-gas plant Technology and Status	1	08-03-2019		1	CO4	R2	
57.	The Energetic and Economics of Biomass systems	1	11-03-2019		1	CO4	R2	
58.	TUTORIAL-7	1	12-03-2019		1	CO4	T2	
59.	Biomass gasification	1	13-03-2019		1	CO4	T2	
No. of classes required to complete UNIT-IV		12			No. of classes taken:			

UNIT-V : DIRECT ENERGY CONVERSION SYSTEMS

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign Weekly
60.	Introduction to direct energy conversion systems	1	14-03-2019		1	CO5	T1	
61.	Peltier effect, seebeck effect	1	15-03-2019		1	CO5	T1	
62.	Thomson effect	1	18-03-2019		1	CO5	T1	
63.	TUTORIAL-8	1	19-03-2019		1	CO5	T1	
64.	Fuel Cells	1	20-03-2019		3	CO5	T1	
65.	Efficiency of Fuel Cells	1	21-03-2019		1	CO5	T1	
66.	Solar Cells	1	22-03-2019		1	CO5	T1	

67.	Thermionic Generation	1	25-03-2019		1	CO5	R2	
68.	Thermoelectric Generation	1	26-03-2019		1	CO5	T1	
69.	MHD Generator-Open Systems		27-03-2019		1	CO5	T1	
70.	MHD Generator-Closed Systems		28-03-2019		1	CO5	T1	
71.	Applications of direct energy energy conversion systems-1		29-03-2019		1	CO5	T1	
72.	Applications of direct energy energy conversion systems		26-03-2019		1	CO5	T1	
No. of classes required to complete UNIT-V		8			No. of classes taken:			

Contents beyond the Syllabus

S.No.	Topics to be covered	No. of Classes Required	Tentative Date of Completion	Actual Date of Completion	Teaching Learning Methods	Learning Outcome COs	Text Book followed	HOD Sign
73.	Solar Energy Flat plate Collectors	1	01-04-2019		1	CO1	T1	

Teaching Learning Methods			
TLM1	Chalk and Talk	**TLM4**	Demonstration (Lab/Field Visit)
TLM2	PPT	**TLM5**	ICT (NPTEL/Swayam Prabha/MOOCS)
TLM3	Tutorial	**TLM6**	Group Discussion/Project

Part - C

EVALUATION PROCESS:

Evaluation Task	COs	Marks
Assignment/Quiz – 1	1	A1=5
Assignment/Quiz – 2	2	A2=5
I-Mid Examination	1,2	B1=20
Assignment/Quiz – 3	3	A3=5
Assignment/Quiz – 4	4	A4=5
Assignment/Quiz – 5	5	A5=5
II-Mid Examination	3,4,5	B2=20
Evaluation of Assignment/Quiz Marks: A=(A1+A2+A3+A4+A5)/5	1,2,3,4,5	A=5
Evaluation of Mid Marks: B=75% of Max(B1,B2)+25% of Min(B1,B2)	1,2,3,4,5	B=20
Cumulative Internal Examination : A+B	**1,2,3,4,5**	**A+B=25**
Semester End Examinations	**1,2,3,4,5**	**C=75**
Total Marks: A+B+C	**1,2,3,4,5**	**100**

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Electronics & Instrumentation Engineering graduates are expected to attain the following program educational objectives (PEOs) within a period of 3-5 years after graduation.
Our graduates will be

PEO1: Successfully utilize engineering and non-engineering principles for design and analysis as needed by their field

PEO2:life-long learner through the successful completion of advanced degree(s), continuing education, or other professional development.

PEO3:Exhibit effective communication, teamwork, leadership skills and ethical behaviour as standard practice in the workplace
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PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

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 modeling 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 enginee**ring 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 for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1- Acquire the ability to explore the design, installation & operation of the basic instrumentation system used in industrial environments and also calibrate the process instruments..

PSO2- Apply appropriate modern Engineering hardware and software tools like PLC, LABVIEW, MATLAB in order to implement and evaluate in process control and instrumentation system along with safety measures that enables him/her to work effectively as an individual and in a multidisciplinary team.

Mr.G.Mahammed Rafi	Mr.S.Premkumar	Prof.G.Mallikarjuna Rao	Dr.B.Poornaiah
Course Instructor	Course Coordinator	Module Coordinator	HOD