GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
I – Semester

Course Title: **Instrumentation Workshop**
(Course Code: 4311702)

Diploma programmer in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	First

1. RATIONALE

Electrical, Electronic, Instrumentation and allied engineering diploma holders are expected to handle various general-purpose tools and measuring instruments in the instrumentation workshop. They have to supervise work related to assembly of units, measurement of various electric parameters and solder and de-solder the electronic components and circuits in the workshop. They are also expected to test the instrumentation loop using appropriate tools and measuring instruments in an industry. This course help to develop skills to select and use appropriate tools, equipment and measuring instruments.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Test various electrical, electronic, pneumatic components and devices using relevant tools and instruments following safe work practices.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Select different electrical, electronic and pneumatic components and devices.
b) Measure basic electrical parameters using appropriate instruments.
c) Solder different electric and electronic and pneumatic components using of appropriate tools.
d) Identify different components of control valve.
e) Follow safe practices to prevent accidents/ hazards to personnel and environment.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	2	1	00	00	25*	25	50

(*): For this practical only course, 25 marks under the practical CA have two components i.e. the assessment of micro-project, which will be done out of 10 marks and the remaining 15

marks are for the assessment of practical. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practice;* ***P*** *-Practical;* ***C*** *– Credit,* ***CA*** *- Continuous Assessment;* ***ESE*** *-End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Measure inner & outer diameter using venire calipers and thickness of the metal sheet with micrometer.	1	02
2	Test the working of different types of Resistor, Capacitor, Inductor, chokes, transformer, fuse, diode, transistor, etc.	1	02*
3	Test the working of different types of flow sensor, pressure sensor, temperature sensor, level sensor, positioning sensor, different components of control valve, etc.	1	02*
4	Test the working of bellow, bourdon tube, pressure switch, Thermometer, Bi-metallic strip, Temperature gauge, Pressure gauge, Float switch, and C-type bourdon tube.	1	02
5	Use Screw driver (Slotted tip, Allen tip, Frearson tip, Phillips tip, Torx tip Hexagon tip), spanner (ring/open/box/adjustable), flexible cable, armored cable, unarmored cable, 1-core cable, 2-core cable, 3-core/ 4-core cable for wiring, Polyurethane (PU) tube, different pneumatic connectors, etc. for basic electro-pneumatic circuit.	1	02
6	Use male and female type connectors of 3-pin plug, 2-pin plug, USB cable, RJ45/ Ethernet connector, HDMI connector, RS-232, PS/2, VGA for connection, etc.	1	02
7	Identify capillary tube of different material and instrument based on given data sheet and name plate.	1	02
8	Prepare specification tables for basic Electrical components, Electronic components, pneumatic components, etc.	1	02
9	Prepare/ Identify different type of Electrical connection, Pneumatic connections, and Mechanical piping connection with help of available tools.	1	02
10	Test the functionality of the Cathode Ray Oscilloscope, Multimeter, Function generator, Signal generator, Voltage source, Current source, and Electronic workbench to measure electrical parameter.	1	02*
11	Test the working of the Pneumatic source, Air filter, Air regulator, 3-way Manifold, Current to Pneumatic converter, and Pneumatic to Current converter to measure pneumatic parameter.	1	02*
12	Measure standard range of current, voltage, pressure, and hydraulic.	1	02*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
13	Connect heat sink, Digital Integrated circuits(IC as per data sheets), jumper wire on white bread board, and Thermocouple/ RTD with Temperature controller.	1	02*
14	Prepare PCB layout manually on paper and using computer software and Calculate the value of Resistor/ Capacitor based on color code.	1	02
15	Perform the Soldering of electronic components on PCB and de-solder all of them from PCB.	1	02*
16	Trace single phase AC circuit/ three phase AC circuit and DC circuit from the given wiring diagram.	1	02
17	Carryout wiring of DC supply/AC supply, Fuse, Relay, MCB/ AC Drive in control / AC motor starter, given controller in control panel as per given wiring diagram.	1	02*
18	Use BP meter and stethoscope.	1	02
19	Make the hole in metal sheet using drilling machine and bend the capillary Stainless steel pipe using pipe bender.	1	02*
20	Perform mock-drill for fire safety in workshop.	2	02*
21	Use the different types of Safety aids and equipment during measurement and wiring in workshop.	2	02
22	Prepare the table of different steps to recycle the electronic waste.	3	02*
	Minimum 14 Practical Exercises		**28**

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*
ii. *Care must be taken in assigning and assessing study report as it is a first year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.*

The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Venire caliper and Micrometer	1, 7
2.	Metal sheet of 3mm thickness	1, 19
3.	Discrete Component Trainer/ Analog component Trainer: 2mm patch cords in interconnecting components, Collection of utilities like fixed and variable D.C. supplies, electronic Components like, LDR, Transistor, Photo diode, IC 78XX, IC 79XX resistors, capacitors, inductors, LED's, Built in variable DC supply dual ± 0 to 15V/ 500mA, fixed DC power supply, ± 12V / 500 mA, fixed DC power supply +5V/500mA, Built in AC supply.	2, 7, 8, 10, 12, 13, 14, 15
4.	Digital Multimeter: 3 1/2 digit display, 9999 counts digital multimeter measures: Vac, Vdc (1000V max), A_{dc}, A_{ac} (10 amp max) ,Resistance (0 - 100 MΩ) , Capacitance.	7, 10, 12, 16, 17
5.	Capacitance type flow sensor, C-type bourdon tube, Pressure switch, Bi-metallic strip, Float switch, Limit switch, Elbow, 5-meter-long pipeline with ½" diameter, T-connector for ½" pipe line, Pneumatic relay, 11-meter-long Polyurethane Tube (PU Tube) with ¼" diameter, Elbow type push fittings for PU Tube, T- type push fitting for PU Tube.	3, 4, 7, 8, 9, 11
6.	Control valve, Current to Pneumatic converter, and Positioner	3, 7, 8, 9
7.	Demonstration Board for single phase AC circuit.	6, 8, 9, 12, 16, 17
8.	Demonstration Board for three phase AC circuit.	6, 8, 9, 12, 16, 17
9.	Demonstration Board for DC circuit.	6, 8, 9, 10, 12, 13, 15, 17
10.	Stripper, Jumper wire, Printed Circuit Board (PCB), Soldering wire, De-soldering pump, Soldering and De-soldering Station with temperature controller.	9, 10, 12, 14, 15, 16
11.	Demonstration Board for operation of Relay, MCB, AC motor starter Controller, and AC Drive.	8, 9, 16, 17
12.	BP meter and stethoscope	18
13.	Drilling machine, tube bender, flaring tools, and Tube cutter.	8, 9, 11, 19
14.	Demonstration Board for Electrical connection.	5, 6, 8, 9, 10, 12, 16
15.	Demonstration Board for Pneumatic connection.	8, 9, 11, 12
16.	Demonstration Board for Mechanical piping connection.	8, 9
17.	Insulating mate, Safety goggles, Hand gloves, electrical safety helmet, arc flash shoot, electric safety shoes, rescue hook, and Fire Extinguisher.	20, 21

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
18.	Spanner(ring/open/box/adjustable)	4, 8, 9
19.	Screw driver (Slotted tip, Allen tip, Frearson tip, Phillips tip, Torx tip Hexagon tip)	5, 6, 8, 9, 10, 11, 13, 16, 17
20.	Pliers and Wire Cutter	5, 6, 8, 9, 10, 13, 15, 16, 17
21.	L-end key	5, 6, 8, 9, 11
22.	Transformer (Step down type : 230VAC to 10VAC , Step up type : 10VAC to 230VAC, Variac)	7, 8, 9, 10, 16, 17
23.	Demonstration Board for male and female type connectors of 3-pin plug, 2-pin plug, USB cable, RJ45/ Ethernet connector, HDMI connector, RS-232, PS/2, and VGA for connection.	7, 6, 8, 9
24.	Variable Frequency Drive type AC drive for Single phase AC motor with Input – 4mA to 20mA, Output- 230 VAC and 0 Hz to 50 Hz.	7, 8, 9, 10, 12, 17
25.	Temperature Controller with measurement range 0 to 200 ^{o}C.	7, 8, 9, 12, 13
26.	MCB for 230 VAC.	7, 8, 9, 16, 17
27.	AC motor starter for Single phase AC motor for 230VAC.	7, 8, 9, 17
28.	Control panel/ Instrumentation penal of size: Length -5m, Width-2m, Hight-10m, within attached panel mount rack, 5 Nos. Single phase AC point, 1 No. Three phase AC supply point, attached SMPS and exhaust fan	7, 9, 16, 17
29.	Guidelines for E-waste management by Ministry of Environment and Forest, and Restriction of Hazardous Substance Directive (RoHS).	21, 22
30.	Butter Paper	14
31.	Thermocouple and Resistance Temperature Detector (RTD)	3, 7, 8, 13
32.	Printed circuit board (PCB)	15
33.	Pneumatic source, Air filter, Air regulator, 3-way Manifold, Current to Pneumatic converter, Pneumatic to Current converter.	7, 8, 9, 11
34.	Cathode Ray Oscilloscope (CRO), Multimeter, Function generator, Signal generator, Voltage source, Current source, and Electronic workbench.	7, 8, 9, 10, 12, 15

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member.

b) Follow safety practices while using electrical, electronics, pneumatic instruments and tools.

c) Realize importance of E-waste management. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit-I **Instrumentation workshop**	1a. Identify different electrical, electronic components and devices used in instrumentation. 1b. Solder the devices in a given circuit 1c. Measure different electrical parameters in the given circuit. 1d. Wire different loops. 1e. Troubleshoot different instrumentation system. 1f. Make Pneumatic electrical, electronic and mechanical Connection.	1.1 **Component and Devices** • **Electronic components identification**: Resistor, Inductor, Capacitor, , transformer, fuse, diodes, Transistor. • **Instrumentation Switch**: Pressure switch, Level switch, Temperature switch, and Flow Switch. • **Instrumentation transmitter:** Differential Pressure Transmitter, Level Transmitter, Temperature Transmitter, and Flow Transmitter. • **Instrumentation measuring device:** Multi-meter, Meggar, CRO, Clamp-on meter. • **AC Source**: Single phase, and Three Phase. • **DC Source:** Battery, and Variable DC Source. • **Signal Generator**: Current Source (4-20mA), Cathode Ray Oscilloscope, Voltage source, Current source, and Function generator.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		1.2 **Soldering**: Techniques to solder and Desolder the electronic components on PCB. 1.3 **Measurement**: measurement of basic electrical parameters (V, I, R, P) with proper instruments and measurement of basic pneumatic parameter with proper instruments. 1.4 **Wiring**: Loop wiring, panel wiring and electrical wiring. 1.5 **Troubleshooting**: Troubleshooting of instrumentation loop and instrumentation panel. 1.6 **Connection**: Pneumatic Connection, Electrical connection, Electronic connections, and Mechanical Connection.
Unit– II **Workshop Safety**	2a. Use different types of safety aids equipment and safety devices properly in a given situation.	2.1 Safety aids and equipment: • Personal Protective Equipment (PPE) • Lab coats, • Safety boots, • Workshop hand glows, • Safety goggles, • Lab apron, • Safety shield, • Sand bucket, • Emergency lights, • Emergency signs/ Placards, • Fire detection and alarm system, • First aid kits, • Spill control kit, • Laboratory chemical hood, • Disposal box, • Emergency action Plan 2.2 Safety Devices: • Safety light curtain, • Safety controller, • Indicator lights,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		• Safety Interlock switches, • Tower light, • Emergency STOP switch, • LED Indicator
Unit-III **E-waste recycling**	3a. Describe the components of Electronic waste. 3b. Explain the steps of recycling process of electrical and Electronic waste	3.1 Components of Electronic waste 3.2 Steps for Recycling process of electronic and electrical waste: • Collection and Transportation, • Shredding and sorting, • Dust Extraction, • Magnetic separation, • Water separation, • Purification of Waste (Plastic, Metal, Glass) • Prepare the recycled material for useful utilization

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Instrumentation workshop	**Not Applicable**				
II	Workshop Safety.					
III	E-waste recycling					

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Prepare specification of some electrical, pneumatic and electronic components.
b) Give seminar on reading a datasheet of electronic and pneumatic components.
c) Undertake a market survey of different electronic Sensors and Instruments.
d) Prepare Job Hazard Analysis report for soldering, De-soldering, and wiring.
e) Prepare Standard Operating Procedure for Drilling, Tube bending, BP meter, stethoscope, and control panel wiring.
f) Prepare the Charts that classify recycling process for electronic waste and plastics.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Introduce E-waste recycling technology among the students.
g) Guide students for reading data sheets.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Different types of electronic component: Prepare a board consist of different Resistor, Capacitor, Inductor, chokes, transformer, fuse, diode, and transistor.
b) Panel wiring: Prepare a Panel that consist AC supply point, SMPS, Relay, MCB/ AC Drive, AC motor starter, and Temperature Controller.
c) Make the hole in metal sheet using drilling machine.
d) Bend the capillary Stainless steel pipe using pipe bender.
e) Electronic Circuit on PCB: Make basic electronic circuit on PCB.
f) Sorting of waste: Compile a report for sorting different types of electronic and plastic waste.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Transducers and Instrumentation	Murthy, D. V. S.	PHI Learning,2011 or latest edition ISBN-10: 8120335694 ISBN-13: 978-8120335691
2	Measurement Systems	Kalsi H.S.	McGraw hill Publishers 2011 Or latest edition SBN-10 : 0070583706 ISBN-13 : 978-0070583702
3	Electronic Instrumentation and Measurements	Bell, D.A.	PHI Learning 2013 Or latest edition ISBN-10 : 019569614X ISBN-13 : 978-0195696141
4	Elements of Electronic Instrumentation and Measurements	Carr , Joseph J.	Pearson Education, 2010 ISBN: 9788131712115, 8131712117
5	Encyclopedia of Electronic Components Volume 1 Resistors, Capacitors, Inductors, Switches, Encoders, Relays, Transistors.	Charles Platt	O'Reilly, United States of America-2013. ISBN: 978-1-449-33389-8
6	Printed Circuit Boards: Design and Technology	Bossart	TMH, latest edition ISBN-10 : 0074515497 ISBN-13 : 978-0074515495
7	Build Your Own Printed Circuit Board	Al Williams	Mc Graw Hill, latest edition ISBN-10 : 0070054088 ISBN-13 : 978-0070054080
8	Making Printed Circuit Boards	Jan Axelsen	Mc Graw Hill, latest edition
9	E-waste: implications, regulations, and management in India and current global best Practices.	Rakesh Johri	TERI Press, New Delhi, ISBN: 9788179931530, 29/09/2015
10	Handbook of Electronic Waste Management 1st Edition	M.N.V. Prasad, Meththika Vithanage, Anwesha Borthakur.	Butterworth-Heinemann, eBook ISBN: 9780128170311, Paperback ISBN: 9780128170304, 21/11/2019

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
11	E-waste Recycling and Management Edition Number-1	Anish Khan,Inamuddin, Abdullah M. Asiri	Springer, Cham, ISBN: 978-3-030-14183-7, 2020
12	ROHS Compliance A Complete Guide - 2020 Edition	Gerardus Blokdyk	5starcooks, ISBN-10: 0655928405, ISBN-13: 978-0655928409, 23/09/2019
13	Extended Producer Responsibility	OECD	OECD, ISBN: 9789264189867, 20/03/2001

14. SOFTWARE/LEARNING WEBSITES

- https://shaileshdhoriyani.webs.com/apps/blog (for basic electronic components)
- https://www.electrical4u.com/types-of-resistor (for Resistor)
- https://www.electronics-tutorials.ws/resistor/res_1.html (for Resistor)
- https://www.electronicshub.org/types-of-diodes/ (for Diodes)
- https://nptel.ac.in (for online courses and video of all engineering branches)
- www.electronicsforu.com (for basic electronic projects and technical videos)
- https://www.vlab.co.in(Virtual Lab for all engineering branches)
- Fritzing – PCB Designing Open Source Software.
- KiCAD – PCB Designing Open Source Software.
- http://dl.mitsubishielectric.com/dl/fa/document/catalog/lvcb/yn-c-0729/y07291307.pdf (for MCB)
- https://www.electricaltechnology.org/2019/07/mcb-mccb-elcb-rcb-rcd-rccb-rcbo.html (for MCB, ELCB,RCCB)
- https://cpcb.nic.in/uploads/Projects/E-Waste/e-waste_amendment_notification_06.04.2018.pdf (For E-waste Recycle guidelines)
- https://cpcb.nic.in/displaypdf.php?id=RS1XYXN0ZS9FLVdhc3RlTV9SdWxlc18yMDE2LnBkZg== (For E-waste Recycle guidelines)
- https://cpcb.nic.in/e-waste/ (For E-waste Recycle guidelines)
- https://www.rohsguide.com/ (For E-waste Recycle guidelines)
- https://www.meity.gov.in/writereaddata/files/1035e_eng.pdf (For E-waste Recycle guidelines)
- https://www.meity.gov.in/content/gazettes (For E-waste Recycle guidelines)

15. PO-COMPETENCY-CO MAPPING

Semester I	Instrumentation Workshop (Course Code: 4311702)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ develop-ment of solutions	PO 4 Engineering Tools, Experimen-tation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage-ment	PO 7 Life-long learning
Competency	**Test various electrical, electronic and pneumatic components and devices using relevant tools and instruments following safe work practices.**						
Course Outcomes							
CO 1) Select different electrical, electronic and pneumatic components and devices.	2	2	1	1	2	1	1
CO 2) Measure basic electrical parameters using appropriate instruments.	2	1	1	2	2	1	1
CO 3) Solder different electric, electronic and pneumatic components using appropriate tools.	2	1	1	1	2	1	1
CO 4) Identify different components of control valve.	3	2	1	1	2	1	1
CO 5) Follow safe practices to prevent accidents/hazards to personnel and environment.	2	1	1	1	3	1	2

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1.	Shri Nayankumar P. Vasava, Lecturer IC- Engineering.	Government Polytechnic, Vyara	8238868622	nayan_vasava1989 @live.com

NITTTR Resource Persons

S. No.	Name and Designation	Department	Contact No.	Email
1.	Mr. Sanjeet Kumar, Assistant Professor	Elect. & Electronics Engg Education	9039210521	skumar@nitttrbpl.ac.in
2.	Dr. C.S. Rajeshwari, Professor	Elect. & Electronics Engg. Education	9340068700	csrajeshwari@nitttrbpl.ac.in