

# Chhattisgarh Swami Vivekanand Technical University, Bhilai

## Diploma in Electronics and Telecommunication Engineering

Semester -V

- A) Course Code : 2028571(028)  
B) Course Title : Antenna and Microwave  
C) Pre-requisite Course Code and Title : Communication System-1, Electronics Devices and circuits  
D) Rationale :

The RF communication links are established with the help of antennas and microwave transmitters & receivers. To install and maintain the RF communication links, knowledge of the microwave signal generation, propagation, amplification and measurement is very essential. This course has been designed to develop the skills in diploma engineer to use and maintain various types of antenna, microwave devices, components and accessories to establish RF link.

E) Course Outcomes:

- CO-1 Apply wave propagation concepts to interpret transmission of various Electromagnetic (EM) frequency bands.  
CO-2 Test different types of antennas.  
CO-3 Apply concepts of transmission line and waveguide to maintain RF communication systems/links.  
CO-4 Maintain the working of different types of linear and cross-field tubes.  
CO-5 Maintain the working of different types solid-state microwave devices.

F) Scheme of Studies:

| S.No | Board of Study   | Course Code   | Course Title              | Scheme of Studies (Hours/Week) |   |   |                        |
|------|------------------|---------------|---------------------------|--------------------------------|---|---|------------------------|
|      |                  |               |                           | L                              | P | T | Total Credit L+T+(P/2) |
| 1    | E&TC Engineering | 2028571 (028) | Antenna & Microwave       | 2                              | - | 1 | 3                      |
| 2    | E&TC Engineering | 2028561 (028) | Antenna & Microwave (Lab) | -                              | 4 | - | 2                      |

Legend: L - Lecture T - Tutorial P - Practical

G) Scheme of Assessment:

| S.No | Board of Study   | Course code   | Course Title              | Schemes of Examination |    |    |           |    |             |
|------|------------------|---------------|---------------------------|------------------------|----|----|-----------|----|-------------|
|      |                  |               |                           | Theory                 |    |    | Practical |    | Total Marks |
|      |                  |               |                           | ESE                    | CT | TA | ESE       | TA |             |
| 1    | E&TC Engineering | 2028571 (028) | Antenna & Microwave       | 70                     | 30 | 30 | -         | -  | 130         |
| 2    | E&TC Engineering | 2028561 (028) | Antenna & Microwave (Lab) | -                      | -  | -  | 30        | 50 | 80          |

Legend: ESE - End semester exam CT - Class Test TA - Teachers Assessment

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### H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

Convert unit of the given physical quantity from one unit system to other.

### CO-1 Apply wave propagation concepts to interpret transmission of various electromagnetic frequency bands.

| Session Outcomes (SOs)  | Laboratory Instruction (LI)  | Class room Instruction (CI)  | Self Learning (SL)  |
|---|--|--|---|
| SO1.1 Describe the given type of modes of wave propagations with the help of suitable sketch.<br>SO1.2 Compare the characteristics of the given type of wave propagation modes.<br>SO1.3 Calculate the MUF for the given angle and frequency.<br>SO1.4 Explain the importance of skip distance for the given ionospheric layer.<br>SO1.5 For the given application, identify the type of wave propagation mode to be used with justification. | LE1.1 Measure skip distance for the given critical frequency, maximum usable frequency and height of the specified atmospheric layers using any simulation software. | <b>Unit-1.0 Wave Propagation</b><br>1.1 Elementary concepts of propagation of Electromagnetic (EM) waves, properties of EM waves, Classification of EM waves bands, guided and unguided wave propagation<br>1.2 Propagation of ground wave, space wave and sky wave<br>1.3 Ionospheric layers: D, E and F layer, Skip distance, Critical frequency, Plasma frequency, Maximum Usable Frequency (MUF), Actual and Virtual height of the ionospheric layer, Multi hops and Duct propagation. | <ul style="list-style-type: none"><li>Compare frequency bands of operations of ground wave, space wave and sky wave.</li><li>List applications of Space and Sky wave propagation.</li><li>Describe properties of the specified ionospheric layer.</li></ul> |

### SW-1 Suggested Sessional Work (SW):

#### a. Assignments:

- Describe the effect of terrain and earth's curvature on the ground wave propagation.
- Summarize characteristics of different types of Ionospheric layer.

#### b. Mini Project:

- Prepare a simulation program to calculate the MUF for the given frequency and angle of the transmitting signal.
- Prepare a simulation program to calculate the skip distance for the given frequency and angle of the transmitting signal.

#### c. Other Activities (Specify):

- Prepare a chart to show the applications of different type of wave propagation modes.
- Prepare a chart of Electromagnetic spectrum indicating frequency bands and their broad application area.

### CO-2 Test different types of antennas.

| Session Outcomes (SOs)  | Laboratory Instruction (LI)  | Class room Instruction (CI)  | Self Learning (SL)   |
|---|--|--|--|
| SO2.1 Define the given antenna parameter.<br>SO2.2 Describe the working principle of the given basic antenna element.<br>SO2.3 Explain the effect of antenna height on the signal reception.<br>SO2.4 Compare the radiation pattern of the given types of antennas.<br>SO2.5 Sketch the radiation pattern of given type of antenna array. | LE2.1 Check the radiation pattern of half wave dipole and find HPBW.<br>LE2.2 Check the radiation pattern of rhombic antenna.<br>LE2.3 Test the performance of the given Yagi –uda antenna.<br>LE2.4 Test the performance of the given parabolic antenna.<br>LE2.5 Test the performance of the given Horn antenna. | <b>Unit 2.0 Antenna Fundamentals</b><br>2.1 Basic definition of antenna and working principle, point source, dipole antenna, Isotropic radiator<br>2.2 Antenna parameters: impedance, radiation resistance, radiation pattern, beam width and beam efficiency, gain, directivity and, radiation intensity, half power BW(HPBW), polarization, antenna losses, antenna efficiency, effective aperture, effective length of antenna<br>2.3 Effects of antenna height on the signal reception<br>2.4 Working Principal, radiation pattern and application of following antennas: Half wave dipole, Loop and Helical antenna, Horn, Yagi-uda, folded dipole and Rhombic Antenna, Parabola reflector antenna and Log periodic antenna<br>2.5 Fundamental of Antenna arrays: Broadside and end fire array, working, radiation pattern and applications | <ul style="list-style-type: none"> <li>Compare different antennas on the basis of antenna parameter.</li> <li>Differentiate between ideal and practical antenna.</li> <li>Summarize the applications of following antennas: Horn, Yagi, Dipole, Rhombic, Helical, wire antenna.</li> </ul> |

### SW-2 Suggested Sessional Work (SW):

#### a. Assignments:

- Explain with justification the need for antenna array.
- Describe the working of Yagi antenna with the help of suitable sketches.

#### b. Mini Project:

- Develop a report on the antenna testing procedure.
- Prepare a report on the types of mobile antennas(Internet based survey).

#### c. Other Activities (Specify):

- Arrange one-day industrial visit to explore TV or Radio transmitting facility.
- Prepare the chart to indicate various antenna radiation patterns and its application.

**Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.**

**CO-3 Apply concepts of transmission line and waveguide to maintain RF communication systems/links.**

| Session Outcomes (SOs)   | Laboratory Instruction (LI)  | Class room Instruction (CI)   | Self Learning (SL)  |
|--|--|---|---|
| <p>SO3.1 Develop the equivalent circuit of a two wire transmission line.</p> <p>SO3.2 Obtain the general equation for a two-wire transmission line.</p> <p>SO3.3 Describe the process of propagation of microwave signals through waveguide.</p> <p>SO3.4 Define the following: cut off wavelength, group and phase velocities, characteristics wave impedance, TE, TM modes, S-Parameters.</p> <p>SO3.5 Differentiate the function of E-Plane Tee, H-Plane Tee and magic Tee.</p> | <p>LE3.1 Measure open circuit and short circuit parameters for the given length of transmission line.</p> <p>LE3.2 Measure VSWR and reflection coefficient for given length of transmission line.</p> <p>LE3.3 Identify various microwave components in the given microwave circuit/communication system.</p> <p>LE3.4 Determine the directivity, insertion loss, and coupling factor for the given directional coupler.</p> | <p><b>Unit 3.0 Transmission Lines and Waveguides</b></p> <p>3.1 Introduction : transmission line, equivalent circuit of transmission line, voltage and current relationship, propagation constants, attenuation constant, characteristic impedance, Reflection coefficient, Standing wave and VSWR, Short circuit and open circuit line, Half wave, quarter wave, eight wave line and their uses, Impedance matching, Co-axial cable</p> <p>3.2 Wave guide: Working principle, types of waveguides: Rectangular , Circular Wave Guide, Modes of propagation(basic idea only), function, characteristics and applications</p> <p>3.3 Microwave components : E plane, H-plane, Magic Tee Directional Coupler, Attenuator, Isolator Circulator, joints, bands, phase shifters(Basic idea only)</p> | <ul style="list-style-type: none"> <li>State characteristics of lossless transmission line.</li> <li>Differentiate between transmission line and waveguide</li> <li>Describe the term Standing wave ratio and explain the procedure to measure it for the given transmission line.</li> </ul> |

**Legend:** CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

### SW-3 Suggested Sessional Work (SW):

#### a. Assignments:

- Explain how Quarter wave line is used as impedance inverter?
- Explain why Hybrid Tee is referred as Magic tee?
- Explain how Quarter wave line acts as a resonant circuit in transmission line.
- Describe the terms characteristic impedance and propagation constant.

#### b. Mini Project:

- Prepare a market survey on the microwave transmission lines used for the TV signal transmission.

**c. Other Activities (Specify):**

- i. Prepare presentation on working of transmission line and waveguide.
- ii. Prepare a chart to indicate the construction of difference between rectangular and circular waveguide.

**Note: Performance under Laboratory and Sessional work may appear in more than one COs/SOs.**

**CO-4 Maintain the working of different types of linear and cross-field tubes.**

| Session Outcomes (SOs)   | Laboratory Instruction (LI)   | Class room Instruction (CI)   | Self Learning (SL)  |
|--|---|---|---|
| <p>SO4.1 Describe the limitation of vacuum tubes at microwave frequency.</p> <p>SO4.2 Explain working of the given types of microwave amplifier with the help suitable sketch.</p> <p>SO4.3 Describe the given type of microwave power measurement method.</p> <p>SO4.4 Explain with justification of significance of VSWR measurement for the power analysis.</p> | <p>LE4.1 Test the performance of klystron amplifier.</p> <p>LE4.2 Test the performance of Reflex klystron.</p> <p>LE4.3 Measure microwave frequency of the given tube using the given (direct and/or indirect) frequency meter.</p> <p>LE4.4 Measure VSWR for the given microwave load.</p> <p>LE4.5 Measure attenuation of the given attenuator.</p> | <p><b>Unit 4.0 Microwave Amplifiers and Measurement</b></p> <p>4.1 Limitations of microwave tube at microwave frequency</p> <p>4.2 Microwave linear beam tube (O Type):</p> <p>4.3 Microwave tubes amplifiers: Klystron - Two cavity and multi cavity, Travelling Wave Tube(TWT) construction, working and applications</p> <p>4.4 Microwave tubes oscillators: Reflex klystron, Magnetron, Backward Wave Oscillator construction, working and applications</p> <p>4.5 Microwave cross field tube(M Type):Magnetron oscillator construction, working and applications</p> <p>4.6 Measurement:VSWR measurement, microwave power, frequency and attenuation measurement</p> | <ul style="list-style-type: none"> <li>• Explain with justification why vacuum tubes are not used at high frequency.</li> <li>• Differentiate between microwave amplifier and oscillator.</li> <li>• Describe attenuation measurement methods used at microwave frequency.</li> </ul> |

**SW-4 Suggested Sessional Work (SW):**

**a. Assignments:**

- i. Differentiate between O-tubes and M-Tubes.
- ii. Describe the working of different types of microwave tube with the help of suitable sketches.
- iii. List applications and limitations of the reflex klystron and two-cavity klystron amplifier.

**b. Mini Project:**

- i. Develop a flow chart for the microwave low, medium and high power measurement.

- ii. Prepare a chart to show the step by step procedure to operate VSWR meter for the microwave measurement.

**c. Other Activities (Specify):**

- i. Prepare a detail chart to indicate construction of Microwave tubes.
- ii. Prepare presentation on how Microwave amplifiers are different from microwave oscillators?

**CO-5 Maintain the working of different types solid-state microwave devices.**

| Session Outcomes (SOs)  | Laboratory Instruction (LI)  | Class room Instruction (CI)  | Self Learning (SL)  |
|---|--|--|---|
| SO5.1 State the limitation of transistor at microwave frequency.<br>SO5.2 Explain principle, construction, working and application of TUNNEL diode<br>SO5.3 Explain the negative resistance principle for IMPATT/TRAPATT diode with sketches<br>SO5.4 Explain the working of a PIN diode as a microwave switch. | LE5.1 Test the performance of TUNNEL diode.<br>LE5.2 Test the performance of GUNN Diode.<br>LE5.3 Test the performance of PIN diode. | <b>Unit 5.0 Microwave Solid State Devices</b><br>5.1 Limitation of transistors at microwave frequencies.<br>5.2 Tunnel diode, Gunn diode (working and construction only)<br>5.3 Transferred electron device: Transit time device, IMPATT & TRAPATT (basic idea only)<br>5.4 PIN diode and their applications | <ul style="list-style-type: none"><li>Describe the advantage and applications of Microwave solid-state devices.</li></ul> |

**SW-5 Suggested Sessional Work (SW):**

**a. Assignments:**

- i. Explain why normal diodes are not used at microwave frequency.
- ii. Explain why it is possible to obtain amplification by using a device, which exhibits negative resistance.

**b. Mini Project:**

- i. Prepare a Internet based survey report on comparative characteristics of microwave solid state devices (GUNN and PIN diodes).
- ii. Develop high frequency amplifier and oscillator circuit using tunnel diode.

**c. Other Activities (Specify):**

- i. Prepare chart to show construction and applications of klystron, travelling wave tube and crossed field amplifier.
- ii. Prepare a chart to indicate drawback of Avalanche devices.

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## I) Suggested Specification Table (For ESA of Classroom Instruction):

| Unit Number | Unit Title                           | Marks Distribution |    |    | Total Marks |
|-------------|--------------------------------------|--------------------|----|----|-------------|
|             |                                      | R                  | U  | A  |             |
| I           | Wave Propagation                     | 4                  | 5  | 5  | 14          |
| II          | Antenna Fundamentals                 | 4                  | 5  | 5  | 14          |
| III         | Transmission Lines and Waveguides    | 4                  | 5  | 5  | 14          |
| IV          | Microwave Amplifiers and Measurement | 5                  | 4  | 5  | 14          |
| V           | Microwave Solid State Devices        | 5                  | 4  | 5  | 14          |
| Total       |                                      | 22                 | 23 | 25 | 70          |

Legend: R: Remember, U: Understand, A: Apply and above

## J) Suggested Specification Table (For ESA of Laboratory Instruction\*):

| Laboratory Instruction Number | Short Laboratory Experiment Titles   | Assessment of Laboratory Work (Marks) |     |           |
|-------------------------------|--|---------------------------------------|-----|-----------|
|                               |  | Performance                           |     | Viva-Voce |
|                               |  | PRA                                   | PDA |           |
| LE1.1                         | Measure skip distance for the given critical frequency, maximum usable frequency and height of the specified atmospheric layers using any simulation software. | 15                                    | 10  | 5         |
| LE2.1                         | Check the radiation pattern of half wave dipole and find HPBW.   | 15                                    | 10  | 5         |
| LE2.2                         | Check the radiation pattern of rhombic antenna.  | 15                                    | 10  | 5         |
| LE2.3                         | Test the performance of the given Yagi –uda antenna.   | 15                                    | 10  | 5         |
| LE2.4                         | Test the performance of the given parabolic antenna.   | 15                                    | 10  | 5         |
| LE2.5                         | Test the performance of the given Horn antenna.  |                                       |     |           |
| LE3.1                         | Measure open circuit and short circuit parameters for the given length of transmission line.   | 15                                    | 10  | 5         |
| LE3.2                         | Measure VSWR and reflection coefficient for given length of transmission line.   | 15                                    | 10  | 5         |
| LE3.3                         | Identify various microwave components in the given microwave circuit/communication system.   | 15                                    | 10  | 5         |
| LE3.4                         | Determine the directivity, insertion loss, and coupling factor for a given directional coupler.  | 15                                    | 10  | 5         |
| LE4.1                         | Test the performance of klystron amplifier.  | 15                                    | 10  | 5         |
| LE4.2                         | Test the performance of Reflex klystron.   | 15                                    | 10  | 5         |
| LE4.3                         | Measure microwave frequency of the given tube using the given (direct and/or indirect) frequency meter.  | 15                                    | 10  | 5         |
| LE4.4                         | Measure VSWR for the given microwave load.   | 15                                    | 10  | 5         |
| LE4.5                         | Measure attenuation of given attenuator.   | 15                                    | 10  | 5         |
| LE5.1                         | Test the performance of TUNNEL diode   | 15                                    | 10  | 5         |
| LE5.2                         | Test the performance of GUNN diode   | 15                                    | 10  | 5         |
| LE5.3                         | Test the performance of PIN diode  | 15                                    | 10  | 5         |

\*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

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**Legend:** PRA: Process Assessment, PDA: Product Assessment

**Note:** Only one experiment has to be performed at the end semester examination of 30 Marks as per assessment scheme.

### K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

### L) Suggested Learning Resources:

#### (a) Books :

| S. No. | Titles                          | Author   | Publisher                               | Edition & Year                                     |
|--------|---------------------------------|--|---|--|
| 1      | Antenna and Wave Propagation    | Prasad, K.D.                                     | SatyaPrakashan, New Delhi               | Edition-2009, ISBN-978-8176842055                  |
| 2      | Antenna And Wave Propagation    | Raju, G.S.N                                      | PEARSON(PHI) Education India, New Delhi | 8 <sup>th</sup> Edition 2012, ISBN-978-8131701843  |
| 3      | Microwave Devices and Circuits  | Liao, Samuel Y                                   | PEARSON(PHI) Education India, New Delhi | 14 <sup>th</sup> edition 2012, ISBN-978-8177583533 |
| 4      | Antenna And Wave Propagation    | Kraus, John D, Ronald, J Marhefka, Khan, Ahmad S | McGraw Hill Education, New Delhi        | 4 <sup>th</sup> edition 2017, ISBN-978-0070671553  |
| 5      | Electronic Communication System | Kennedy,George; Davis, Brendan ; Prasanna, Srm   | McGraw Hill Education, New Delhi        | 5 <sup>th</sup> edition,2011 ISBN-978-0071077828   |
| 6      | Microwave Engineering           | Das, Annapurna and Das, S. K.                    | McGraw Hill, New Delhi                  | (3 <sup>rd</sup> edition 2017,ISBN: 978-9332902879 |
| 7      | Microwave Engineering           | Gupta, Sanjeev                                   | Khanna Publication, Naisadak Delhi      | (3rd edition,2015, ISBN: 9788174090878             |

#### (b) Open source software and website address:

1. [https://www.tutorialspoint.com/antenna\\_theory/antenna\\_theory\\_types\\_of\\_propagation.htm](https://www.tutorialspoint.com/antenna_theory/antenna_theory_types_of_propagation.htm)
2. [https://en.wikipedia.org/wiki/Wave\\_propagation](https://en.wikipedia.org/wiki/Wave_propagation)
3. [http://www.iitg.ac.in/engfac/krs/public\\_html/lab/ee442/Exp4.pdf](http://www.iitg.ac.in/engfac/krs/public_html/lab/ee442/Exp4.pdf) (reflex klystron)
4. <http://www.asti.edu.in/images/pdf/departments/ece-downloads/academic-manuals/lab-manual-2014-15-1sem/mw-and-dc-4ece/mwdc-lab.pdf>
5. <https://www.svce.ac.in/departments/ece/archives/Learning%20Material/ARCHIVES2014/UG/Semester%206/EC2353-Antennas%20and%20Wave%20Propagation/EC2353%20Unit%205.pdf>



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6. <https://circuitglobe.com/transmission-lines.html> (transmission line)
7. [https://www.tutorialspoint.com/microwave\\_engineering/microwave\\_engineering\\_transmission\\_lines.htm](https://www.tutorialspoint.com/microwave_engineering/microwave_engineering_transmission_lines.htm)
8. <https://www.electronics-notes.com/articles/antennas-propagation/vswr-return-loss/what-is-vswr.php>
9. [https://www.tutorialspoint.com/antenna\\_theory/antenna\\_theory\\_parameters.htm](https://www.tutorialspoint.com/antenna_theory/antenna_theory_parameters.htm)
10. [https://www.tutorialspoint.com/microwave\\_engineering/microwave\\_engineering\\_travelling\\_wave\\_tube.htm](https://www.tutorialspoint.com/microwave_engineering/microwave_engineering_travelling_wave_tube.htm)
11. [https://www.tutorialspoint.com/microwave\\_engineering/microwave\\_engineering\\_avalanche\\_transient\\_time\\_devices.htm](https://www.tutorialspoint.com/microwave_engineering/microwave_engineering_avalanche_transient_time_devices.htm)
12. Microwave fundamentals:-[www.nptelvideos.in/microwave\\_engineering](http://www.nptelvideos.in/microwave_engineering)
13. Microwave:-[www.learnerstv.com/free-engineering](http://www.learnerstv.com/free-engineering)
14. Rectangular Waveguide:- [www.ece.uprm.edu/ppt/rectangularwave](http://www.ece.uprm.edu/ppt/rectangularwave)
15. Waveguide:- [www.academia.edu/waveguide](http://www.academia.edu/waveguide)
16. Microwave engineering Book:-[monitor.westernfriend.org/microwave-engineering-by-sanjeev-gupta.pdf](http://monitor.westernfriend.org/microwave-engineering-by-sanjeev-gupta.pdf)

### M) List of Major Laboratory Equipment and Tools:

| S. No. | Name of Equipment           | Broad Specifications  | Relevant Experiment Number                              |
|--------|-----------------------------|---|---|
| 1.     | <b>Microwave Test Bench</b> | <b>X Band (Klystron based)/</b> or any other equivalent, Klystron Power Supply, Klystron tube with Klystron mounts, Frequency meter, Variable attenuator, Detector mount, Wave guide stand, SWR meter and oscilloscope, E Plane Tee, H Plane Tee and Magic Tee, Isolator and Circulator, Directional Coupler, Horn Antenna proto type   | LE4.1,LE4.2,LE4.3                                       |
| 2.     | Klystron power supply       | Voltage - 240 - 420 VDC,Variable Current - 50mA, Regulation - 0.25% for10%,Ripple - 5 mVrms (ON Load),Repeller Supply - P-18 V to -270 V DCVariable (ON Load),Filament Supply 6.3 VDC (adjustable on rear panel),Over-Load trip current - 65 mA   | LE4.1,LE4.2,LE4.3                                       |
| 3.     | Microwave test bench –X     | Band (GUNN Diode based)Voltage Range : 0 to 12 Volts (Positive) Current : 750 mA (max.) Stability : 0.2% for $\pm 10\%$ variations in the mains voltage. Ripple : 1 mV rms. Modulation Voltage : 0 - $\pm 10$ Volts (P-P) Frequency : 800 – 1100 Hz. Output connector : BNC Female for Gunn Oscillator TNC Female for Pin Modulator)/ or any other equivalent, Gunn oscillator, Gun power supply, PIN modulator, Isolator, Frequency meter, Variable attenuator, Detector mount, Wave guide stands, SWR Meter, Cables and accessories | LE5.2   |
| 4.     | VSWR meter                  | Range: 70 dB input attenuation provides 60 dB in 10 dB steps, accuracy $\pm 0.2$ dB per 10 dB steps maximum cumulative error $\pm 0.5$ dB.Input Connector: BNC(F)<br>Frequency: 1000Hz $\pm 10\%$<br>Power: 230 Volts AC, 50Hz, mains supply<br>Noise level: At least 5 dB below full scale   | LE2.1,LE2.2,LE2.3, LE2.4,LE2.5,LE3.1, LE3.2,LE3.3,LE3.4 |
| 5.     | Frequency meter             | Frequency range: 8.2 -12.4 GHz<br>Waveguide type: WR- 90,Flange type: UG- 39/U<br>Calibration accuracy: $\pm 2\%$ ,Min. insertion loss: 0.2 dB  | LE4.3   |

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| S. No. | Name of Equipment                  | Broad Specifications  | Relevant Experiment Number |
|--------|------------------------------------|---|----------------------------|
| 6.     | PIN Modulator                      | Bias Voltage 10 Volts ,Output Connector TNC(F)<br>Frequency Band J X Ku K Ka                                | LE5.3                      |
| 7.     | List of Software/Learning Websites | RF Tool box: MATLAB and SIMULINK or any other open source software, EZNEC, HFSS-CST, VSim, Microwave office | LE1.1                      |

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N) Mapping of POs & PSOs with COs:

| Course Outcomes (COs)   | Programme Outcomes (POs) |                              |                                  |                           |                                  |  |                |                                  |                       |                             | Programme Specific Outcomes (PSOs) |       |
|---|--------------------------|------------------------------|----------------------------------|---------------------------|----------------------------------|--|----------------|----------------------------------|-----------------------|-----------------------------|------------------------------------|-------|
|   | PO-1<br>Basic knowledge  | PO-2<br>Discipline knowledge | PO-3<br>Experiments and practice | PO-4<br>Engineering Tools | PO-5<br>The engineer and society | PO-6<br>Environment and sustainability | PO-7<br>Ethics | PO-8<br>Individual and team work | PO-9<br>Communication | PO-10<br>Life-long learning | PSO-1                              | PSO-2 |
| CO-1 Apply wave propagation concepts to interpret transmission of various Electromagnetic (EM) frequency bands. | 1                        | 2                            | 2                                | 2                         | 1                                | 2                                      | 1              | 2                                | 1                     | 1                           | 2                                  | 2     |
| CO-2 Test different types of antennas.  | 2                        | 3                            | 3                                | 3                         | 1                                | 2                                      | 1              | 2                                | 1                     | 1                           | 3                                  | 3     |
| CO-3 Apply concepts of transmission line and waveguide to maintain RF communication systems/links.              | 2                        | 3                            | 3                                | 3                         | 1                                | 2                                      | 1              | 2                                | 1                     | 1                           | 3                                  | 3     |
| CO-4 Maintain the working of different types of linear and cross-field tubes.                                   | 2                        | 3                            | 3                                | 3                         | 1                                | 2                                      | 1              | 2                                | 1                     | 1                           | 3                                  | 3     |
| CO-5 Maintain the working of different types solid-state microwave devices.                                     | 2                        | 3                            | 3                                | 3                         | 1                                | 2                                      | 1              | 2                                | 1                     | 1                           | 3                                  | 3     |

Legend:1 – Low, 2 – Medium, 3 – High

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## O) Course Curriculum Map:

| POs & PSOs No.                      | COs No.& Titles   | SOs No.                                | Laboratory Instruction (LI)            | Classroom Instruction (CI)   | Self Learning (SL)                    |
|-------------------------------------|---|--|--|--|---------------------------------------|
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-1 Apply wave propagation concepts to interpret transmission of various Electromagnetic (EM) frequency bands. | SO1.1, SO1.2<br>SO1.3, SO1.4<br>SO1.5  | LE1.1                                  | Unit 1.0 Wave Propagation<br>1.1,1.2,1.3                                     | As mentioned in relevant page numbers |
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-2 Test different types of antennas.  | SO.2.1,SO.2.2<br>SO2.3,SO2.4<br>SO2.5  | LE2.1, LE2.2,<br>LE2.3,LE2.4,<br>LE2.5 | Unit 2.0Antenna Fundamentals<br>2.1,2.2,2.3, 2.4 ,2.5                        |                                       |
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-3 Apply concepts of transmission line and waveguide to maintain RF communication systems/links.              | SO.3.1,SO3.2<br>SO3.3, SO3.4,<br>SO3.5 | LE3.1,LE3.2<br>LE3.3,LE3.4             | Unit 3.0 Transmission Lines and Waveguides<br>3.1,3.2,3.3                    |                                       |
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-4 Maintain the working of different types of linear and cross-field tubes.                                   | SO4.1,SO4.2<br>SO4.3, SO4.4,           | LE4.1, LE4.2<br>LE4.3, LE4.4<br>LE4.5  | Unit 4.0 Microwave Amplifiers and Measurements<br>4.1,4.2,4.3, 4.4, 4.5, 4.6 |                                       |
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-5 Maintain the working of different types solid-state microwave devices.                                     | SO5.1,SO5.2<br>SO5.3,SO5.4             | LE5.1, LE5.2,<br>LE5.3                 | Unit 5.0 Microwave Solid State Devices<br>5.1,5.2,5.3,5.4                    |                                       |

**Legend:** CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

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- A) Course Code : 2028572(028)
- B) Course Title : Communication System -II
- C) Pre-requisite Course Code and Title : Communication System- I, Digital Electronics, Analog Electronics, Basic Electronics and circuits
- D) Rationale :  
Digital communication is the backbone of present telecommunication industry. Employment in the rapidly growing communications industry can be assured by the knowledge of fundamentals of system level working and to maintain the Digital Communication systems. This course is design to given good exposure of the Digital Communication systems and Digital Communication techniques and also helps to develop concepts to maintain more advanced communication systems.
- E) Course Outcomes:
- CO-1 Analyze different types of pulse modulation techniques.
- CO-2 Test and analyze Pulse Code Modulated and Demodulated signal.
- CO-3 Compute the bandwidth and power requirement of basic digital modulation techniques namely ASK, PSK and FSK.
- CO-4 Analyze M-ary digital modulation techniques used to increase transmission data rate.
- CO-5 Analyze Spread Spectrum modulation and demodulation technique.

F) Scheme of Studies:

| S.No | Board of Study   | Course Code   | Course Title                   | Scheme of Studies (Hours/Week) |   |   |                      |
|------|------------------|---------------|--------------------------------|--------------------------------|---|---|----------------------|
|      |                  |               |                                | L                              | P | T | Total Credit L+T+P/2 |
| 1    | E&TC Engineering | 2028572 (028) | Communication System -II       | 2                              | - | 1 | 3                    |
| 2    | E&TC Engineering | 2028562 (028) | Communication System -II (Lab) | -                              | 4 | - | 2                    |

Legend: L - Lecture T - Tutorial P - Practical

G) Scheme of Assessment:

| S.No | Board of Study   | Course Code   | Course Title                   | Schemes of Examination |    |    |           |    |             |
|------|------------------|---------------|--------------------------------|------------------------|----|----|-----------|----|-------------|
|      |                  |               |                                | Theory                 |    |    | Practical |    | Total Marks |
|      |                  |               |                                | ESE                    | CT | TA | ESE       | TA |             |
| 1    | E&TC Engineering | 2028572 (028) | Communication System -II       | 70                     | 30 | 30 | -         | -  | 130         |
| 2    | E&TC Engineering | 2028562 (028) | Communication System -II (Lab) | -                      | -  | -  | 30        | 50 | 80          |

Legend: ESE - End semester exam CT - Class Test TA - Teachers Assessment

### H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

Convert unit of the given physical quantity from one unit system to other.

### CO-1 Analyze different types of pulse modulation techniques.

| Session Outcomes (SOs)  | Laboratory Instruction (LI)  | Class room Instruction (CI)   | Self Learning (SL)  |
|---|--|---|---|
| SO1.1 Describe the given type of sampling technique with example.<br>SO1.2 Explain the effect of under sampling for the given modulating signal.<br>SO1.3 Compare the given parameters of different pulse analog modulation techniques. (PAM, PWM and PPM). | LE1.1 Test the performance of Pulse Amplitude Modulation (PAM) and Demodulation circuit.<br>LE1.2 Implement and test PWM and demodulation circuit contain IC-555.<br>LE1.3 Implement and test PPM and demodulation circuit contain IC-555. | <b>Unit 1.0 Pulse Analog Modulation Techniques</b><br>1.1 Sampling Theory: Sampling theorem in time and frequency domain, Aliasing phenomenon, Sampling techniques (Ideal, Natural and Flat top), aperture effect and equalization<br>1.2 Pulse Modulation: Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM) : Basic definition, generation and detection procedure, advantages, disadvantages and applications | <ul style="list-style-type: none"><li>Explain the procedure to avoid aliasing.</li><li>List the applications of Pulse modulation technique.</li></ul> |

### SW-1 Suggested Sessional Work (SW):

#### a. Assignments:

- Compare PAM, PPM and PWM techniques.
- Explain the necessity of sampling for the modulation process.

#### b. Mini Project:

- Prepare a chart to show generation and detection of various types of pulse modulation techniques.
- Develop and test a circuit to generate pulse position modulated signal for the specified parameters.

#### c. Other Activities (Specify):

- Demonstrate the pulse modulation techniques by animation video.

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### CO-2 Test and analyze Pulse Code Modulated and Demodulated signal.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)   | Class room Instruction (CI)   | Self Learning (SL)   |
|--|---|---|--|
| SO2.1 Describe the given advantages of Digital pulse modulation technique.<br>SO2.2 Explain the quantization procedure with example.<br>SO2.3 Explain the characteristics of the given type of digital pulse modulation technique (PCM, DPCM, DM).<br>SO2.4 Explain how the TDM system utilizes the common channel by the independent message sources.<br>SO2.5 Explain the need for companding? | LE2.1 Generate sampled and reconstructed low pass signal using simulation software.<br>LE2.2 Generate Uniform quantized analog signal for the given number of quantization level using simulation software.<br>LE2.3 Generate and trace the Pulse Code Modulated(PCM) and demodulated waveforms for different sampling and modulating frequency.<br>LE2.4 Test the performance of DM circuit.<br>LE2.5 Test the performance of ADM circuit. | <b>Unit 2.0 Pulse Digital Modulation</b><br>2.1 Advantage of Digital Communication, Quantization, Uniform and Nonuniform quantization, Pulse Code Modulation(PCM): generation and detection, Noise consideration in PCM, companding<br>2.2 Differential Pulse Code Modulation (DPCM), Delta Modulation(DM), Adaptive Delta Modulation (ADM) generation, detection, applications, advantages and disadvantages<br>2.3 Time division multiplexing(TDM) and Frequency division multiplexing(FDM): system level working, applications | <ul style="list-style-type: none"><li>Describe slope overload distortion and granular noise in delta modulation, and how it is removed in ADM?</li><li>List the major drawback of digital communication.</li><li>List the three basic functions of regenerative repeater used in digital communication system.</li></ul> |

### SW-2 Suggested Sessional Work (SW):

#### a. Assignments:

- Compare working of FDM and TDM technique.
- Differentiate between DM and DPCM.
- Explain the necessity of non-uniform quantization with justification.

#### b. Mini Project:

- Demonstrate Time Division Multiplexing and de-multiplexing process for Pulse Amplitude Modulated signals.
- Prepare a chart to demonstrate the various encoding schemes for a given digital data stream.

#### c. Other Activities (Specify):

- Conduct a seminar on the applications of PCM and other digital modulation technique.

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**CO-3** Compute the bandwidth and power requirement of basic digital modulation scheme namely ASK, PSK and FSK.

| Session Outcomes (SOs)  | Laboratory Instruction (LI)  | Class room Instruction (CI)  | Self Learning (SL)  |
|---|--|--|---|
| <p>SO3.1 Describe the giventype of digital band pass modulation scheme.</p> <p>SO3.2 Explain the function of the given block of the BASK, BFSK and BPSK transmitter.</p> <p>SO3.3 Describe the procedure to demodulate BASK, BFSK &amp; BPSK Signal using coherent &amp;noncoherent detection.</p> <p>SO3.4 Calculate the bandwidth required for the given type of binary modulation technique.</p> | <p>LE3.1 Test the performance of ASK modulator and demodulator circuit.</p> <p>LE3.2 Test the performance of FSK modulator and demodulator circuit.</p> <p>LE3.3 Test the performance of PSK modulator and demodulator circuit.</p> <p>LE3.4 Test the performance of BPSK modulator and demodulator circuit.</p> | <p><b>Unit 3.0 Digital Band Pass Modulation Techniques</b></p> <p>3.1 Principles of Amplitude Shift Keying(ASK), Frequency Shift Keying(FSK) and Phase Shift Keying (PSK) Generation and Detection, bandwidth and power requirement, coherent and nonchoherent detection technique</p> <p>3.2 Concepts of binary modulation techniques,Binary ASK(BASK), Binary FSK(BFSK) and Binary PSK(BPSK)</p> <p>3.3 Comparison of ASK, FSK and PSK</p> | <ul style="list-style-type: none"> <li>Describe advantages of ASK technique compare to other keying technique.</li> </ul> |

**Legend:** CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

### SW-3 Suggested Sessional Work (SW):

#### a. Assignments:

- Compare characteristics parameter of BASK, BFSK and BPSK .

#### b. Mini Project:

- Generate Binary Amplitude Shift Keying signals using MATLAB/Scilab software.
- Generate Binary Frequency Shift Keying signals using MATLAB/Scilab software
- Generate Binary Phase shift keyingsignals using MATLAB/Scilab software



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### CO-4 Analyze M-ary digital modulation techniques to increase transmission data rate.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)  | Class room Instruction (CI)  | Self Learning (SL)   |
|--|--|--|--|
| <p>SO4.1 Describe with sketch the given type of PSK generation and detection technique.</p> <p>SO4.2 Describe the generation and detection of QAM with the help of block diagram.</p> <p>SO4.3 Explain working of the given type of M-ary transmitter and receiver with the help of block diagram.</p> <p>SO4.4 Describe the given type of M-ary digital band pass modulation technique.</p> | <p>LE4.1 Test the performance of QPSK modulator and demodulator circuit.</p> <p>LE4.2 Test the performance of QAM modulator and demodulator circuit.</p> | <p><b>Unit 4.0 Other Digital Modulation Techniques</b></p> <p>4.1 Fundamentals of BPSK, DPSK, and QPSK, generation and detection of DPSK, QPSK</p> <p>4.2 Fundamentals of Quadrature Amplitude Modulation (QAM) &amp; Minimum Shift Keying(MSK)</p> <p>4.3 M-ary digital modulation scheme (M-ary PSK, M-ary QAM, M-ary FSK)</p> | <ul style="list-style-type: none"> <li>Performance comparison of QPSK and QAM.</li> <li>Describe the advantages of MSK over QPSK technique.</li> </ul> |

### SW-4 Suggested Sessional Work (SW):

#### a. Assignments:

- List the applications of M-ary modulation scheme.

#### b. Mini Project:

- Prepare a chart to show performance comparison of digital modulation schemes.
- Generate Quadrature Phase Shift Keying technique using MATLAB/Scilab software
- Generate Differential Phase shift keying technique using MATLAB software.

### CO-5 Analyze Spread Spectrum modulation and demodulation technique.

| Session Outcomes (SOs)  | Laboratory Instruction (LI)  | Class room Instruction (CI)   | Self Learning (SL)   |
|---|--|---|--|
| <p>SO5.1 Differentiate between standard narrowband and spread spectrum communication system.</p> <p>SO5.2 Use specified generator functions to generate</p> | <p>LE5.1 Test the performance of Frequency Hopping Spread Spectrum (FHSS) Modulation and Demodulation circuit.</p> <p>LE5.2 Test the output of generation and demodulation circuit of DSSS</p> | <p><b>Unit 5.0 Spread Spectrum Communication</b></p> <p>5.1 Frequency Hopping Spread Spectrum (FHSS) System, Application of FHSS, fast and low frequency hopping</p> <p>5.2 Direct Sequence Spread Spectrum (DSSS),</p> | <ul style="list-style-type: none"> <li>Define throughput, process gain, chip rate, jamming margin of any PN sequence</li> <li>Compare slow and fast</li> </ul> |

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| Session Outcomes (SOs)   | Laboratory Instruction (LI)   | Class room Instruction (CI)   | Self Learning (SL)   |
|--|---|---|--|
| pseudorandom codes.<br>SO5.3 Describe the types of spread spectrum modulation formats (FHSS & DSSS).<br>SO5.4 Compare spread – spectrum approach in frequency domain and in time domain with the help of suitable illustrations. | modulated signal.<br>LE5.3 Generate PN -Sequence for the given number of sequences. (Use simulation software)<br>LE5.4 Analyze the output signals of the GSM trainer kit. | Features , generation and detection of DSSS<br>5.3 Code Division Multiple Access (CDMA) of DSSS,PN sequence generation, properties<br>5.4 CDMA in Cellular Phone Networks and GPS<br>5.5 Multiple access techniques: FDAM,TDMA and CDMA | hopping.<br>• Outline the distinct features of CDMA technique. |

**Legend:** CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others) , LI : Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

### SW-5 Suggested Sessional Work (SW):

#### a. Assignments:

- Describe how spread spectrum is used for GPS.
- Specify the significance of Signal to Interference plus-Noise Ratio (SINR) in DS-CDMA systems.

#### b. Mini Project:

- Prepare a report on Spread spectrum based communication systems.

#### c. Other Activities (Specify):

- Seminar on applications of CDMA in cellular communication.

**Note:** Performance under Laboratory and Sessional work may appear in more than one COs/SOs.)

### I) Suggested Specification Table (For ESA of Classroom Instruction):

| Unit Number  | Unit Title                              | Marks Distribution |           |           | Total Marks |
|--------------|---|--------------------|-----------|-----------|-------------|
|              |   | R                  | U         | A         |             |
| I            | Pulse Analog Modulation Techniques      | 2                  | 5         | 6         | 13          |
| II           | Pulse Digital Modulation                | 4                  | 6         | 8         | 18          |
| III          | Digital Band Pass Modulation Techniques | 1                  | 3         | 6         | 10          |
| IV           | Other Digital Modulation Techniques     | 2                  | 6         | 7         | 15          |
| V            | Spread Spectrum Communication           | 2                  | 6         | 6         | 14          |
| <b>Total</b> |   | <b>11</b>          | <b>26</b> | <b>33</b> | <b>70</b>   |

**Legend:** R: Remember, U: Understand, A: Apply and above

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J) Suggested Specification Table (For ESA of Laboratory Instruction\*):

| Laboratory Instruction Number | Short Laboratory Experiment Titles   | Assessment of Laboratory Work (Marks) |     |           |
|-------------------------------|--|---------------------------------------|-----|-----------|
|                               |  | Performance                           |     | Viva-Voce |
|                               |  | PRA                                   | PDA |           |
| LE1.1                         | Test the performance of Pulse Amplitude Modulation(PAM) and Demodulation circuit.  | 15                                    | 10  | 5         |
| LE1.2                         | Implement and test PWM and demodulation circuit contain IC-555.  | 15                                    | 10  | 5         |
| LE1.3                         | Implement and test PPM and demodulation circuit contain IC-555.  | 15                                    | 10  | 5         |
| LE2.1                         | Generate sampled and reconstructed low pass signal using simulation software.  | 15                                    | 10  | 5         |
| LE2.2                         | Generate Uniform quantize analog signal for the given number of quantization level using simulation software.                | 15                                    | 10  | 5         |
| LE2.3                         | Generate and trace the Pulse Code Modulated (PCM) and demodulated waveforms for different sampling and modulating frequency. | 15                                    | 10  | 5         |
| LE2.4                         | Test the performance of DM circuit.  | 15                                    | 10  | 5         |
| LE2.5                         | Test the performance of ADM circuit.   | 15                                    | 10  | 5         |
| LE3.1                         | Test the performance of ASK modulator and demodulator circuit.   | 15                                    | 10  | 5         |
| LE3.2                         | Test the performance of FSK modulator and demodulator circuit.   | 15                                    | 10  | 5         |
| LE3.3                         | Test the performance of PSK modulator and demodulator circuit.   | 15                                    | 10  | 5         |
| LE3.4                         | Test the performance of BPSK modulator and demodulator circuit.  | 15                                    | 10  | 5         |
| LE4.1                         | Test the performance of QPSK modulator and demodulator circuit.  | 15                                    | 10  | 5         |
| LE4.2                         | Test the performance of QAM modulator and demodulator circuit.   | 15                                    | 10  | 5         |
| LE5.1                         | Test the performance of Hopping Spread Spectrum (FHSS) Modulation and Demodulation circuit.                                  | 15                                    | 10  | 5         |
| LE5.2                         | Test the output of generation and demodulation circuit of DSSS modulated signal.   | 15                                    | 10  | 5         |
| LE5.3                         | Generate PN- Sequence for the given number of sequences.   | 15                                    | 10  | 5         |
| LE5.4                         | Analyze the output signals of the GSM trainer kit.   | 15                                    | 10  | 5         |

\*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

**Legend:** PRA: Process Assessment, PDA: Product Assessment

**Note:** Only one experiment has to be performed at the end semester examination of **30**Marks as per assessment scheme.

### K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

### L) Suggested Learning Resources:

#### (a) Books :

| S. No. | Titles  | Author                                    | Publisher               | Edition & Year                          |
|--------|---|---|-------------------------|---|
| 1      | Modern Digital and Analog Communication Systems | B.P.Lathi, Zhi Ding, Hari M. Gupta        | Oxford University Press | Fourth Edition, ISBN-13: 978-0199476282 |
| 2      | Communication Systems                           | Simon Haykin                              | John Wiley & Sons       | Fourth Edition, ISBN-13:978-8126509041  |
| 3      | Introduction to Analog & Digital Communication  | Simon Haykin, Michael Moher               | John Wiley & Sons       | Second Edition, ISBN-13: 978-8126536535 |
| 4      | Principles of Communication Systems             | Taub H., Schilling D.L., Saha G.          | Tata McGraw Hill        | Fourth Edition, ISBN-13:978-1259029851  |
| 5      | Communication Systems Engineering               | Proakis J.G. and Salehi M.                | Pearson Educations      | Second Edition, ISBN-13: 978-0130617934 |
| 6      | Digital Communication                           | Barry J.R., Lee E.A. & Messerschmitt D.G. | Springer                | Third Edition, ISBN-13:978-1461349754   |
| 7      | Digital Communications                          | Proakis J.G. and Salehi M.                | Tata McGraw Hill        | Fifth Edition, ISBN-13:978-0072957167   |

#### (b) Open source software and website address:

1. Video lecture:-[www.nptelvideos.in/communication\\_engineering](http://www.nptelvideos.in/communication_engineering).
2. Digital Modulation technique:-<https://www.youtube.com/watch?v=GLnGVB92K78>
3. Multiple access:-<https://www.youtube.com/watch?v=vtiup1w1c4E>
4. Multiple access:-[https://www.youtube.com/watch?v=AKXFwwcw\\_E](https://www.youtube.com/watch?v=AKXFwwcw_E)
5. CDMA:-<https://www.youtube.com/watch?v=vdbc9P3U-Xo>
6. Digital Communication:-[https://www.slideshare.net/lineking/digital-communication-system?qid=2ad04efb-5203-4d01-ad26-65e2c9224c8e&v=&b=&from\\_search=2www.youtube.com /Digital communication circuits](https://www.slideshare.net/lineking/digital-communication-system?qid=2ad04efb-5203-4d01-ad26-65e2c9224c8e&v=&b=&from_search=2www.youtube.com/Digital%20communication%20circuits)

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7. Digital communication tutorial :-<http://www.nptelvideos.in/2012/12/digital-communication.html>
8. Data communication and Networking:- <http://datacombasic.blogspot.in/2011/03/e-and-t-carrier.html>
9. SCILAB

### M) List of Major Laboratory Equipment and Tools:

| S. No. | Name of Equipment  | Broad Specifications  | Relevant Experiment Number  |
|--------|--|---|---|
| 1.     | Trainer Kit for generation and detection of PAM, PWM & PPM.  | Power Supply 110 – 240 V, 50Hz, Lab Manuals with detail   | LE1.1,LE1.2,LE1.3   |
| 2.     | PCM , DPCM, DM and ADM Trainer kit                           | Power Supply 110 – 240 V, 50Hz, Lab Manuals with detail   | LE2.3,LE2.4,2.5   |
| 3.     | ASK, FSK and PSK Trainer Kit for (generation and detection ) | Power Supply 110 – 240 V, 50Hz, Lab Manuals with detail   | LE3.1,LE3.2,LE3.3, LE3.4  |
| 4.     | FHSS and DSSS Trainer Kit                                    | Power Supply 110 – 240 V, 50Hz, Lab Manuals with detail   | LE5.1, LE5.2  |
| 5.     | QPSK and QAM Trainer Kit                                     | Power Supply 110 – 240 V, 50Hz, Lab Manuals with detail   | LE4.1, LE4.2  |
| 6.     | Variable DC Power Supply                                     | Output: -15 to +15V (Variable), 0 – 5A  | All   |
| 7.     | Digital Oscilloscope   | Bandwidth 100MHz  | LE1.1,LE1.2,LE1.3, LE3.1,LE3.2,LE3.3, LE3.4LE4.1, LE4.2, LE5.1, LE5.2 |
| 8.     | Function Generator   | Signals of choice up to at least 50 MHz.  | LE1.1,LE1.2,LE1.3, LE3.1,LE3.2,LE3.3, LE3.4LE4.1, LE4.2, LE5.1, LE5.2 |
| 9.     | Spectrum Analyzer  | Frequency range up to 1 GHz   | LE1.1,LE1.2,LE1.3, LE3.1,LE3.2,LE3.3, LE3.4LE4.1, LE4.2               |
| 10.    | Multimeter   | Measurements: DCV, DCI, True RMS ACV, ACI, Frequency, Capacitance, Temperature, Diode & continuity. | LE1.1,LE1.2,LE1.3, LE3.1,LE3.2,LE3.3, LE3.4LE4.1, LE4.2, LE5.1, LE5.2 |

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N) Mapping of POs & PSOs with COs:

| Course Outcomes (COs)  | Programme Outcomes (POs) |                              |                                  |                           |                                  |  |                |                                  |                       |                             | Programme Specific Outcomes (PSOs) |       |
|--|--------------------------|------------------------------|----------------------------------|---------------------------|----------------------------------|--|----------------|----------------------------------|-----------------------|-----------------------------|------------------------------------|-------|
|  | PO-1<br>Basic knowledge  | PO-2<br>Discipline knowledge | PO-3<br>Experiments and practice | PO-4<br>Engineering Tools | PO-5<br>The engineer and society | PO-6<br>Environment and sustainability | PO-7<br>Ethics | PO-8<br>Individual and team work | PO-9<br>Communication | PO-10<br>Life-long learning | PSO-1                              | PSO-2 |
| CO-1 Analyze different types of pulse modulation techniques.   | 2                        | 3                            | 3                                | 3                         | 1                                | 1                                      | 1              | 2                                | 2                     | 1                           | 2                                  | 3     |
| CO-2 Test and analyze Pulse Code Modulated and Demodulated signal.   | 2                        | 3                            | 3                                | 3                         | 1                                | 1                                      | 1              | 2                                | 2                     | 1                           | 3                                  | 3     |
| CO-3 Compute the bandwidth and power requirement of basic digital modulation techniques namely ASK, PSK and FSK. | 2                        | 3                            | 3                                | 3                         | 1                                | 1                                      | 1              | 2                                | 2                     | 1                           | 3                                  | 3     |
| CO-4 Analyze M-ary digital modulation techniques used to increase transmission data rate.                        | 2                        | 3                            | 3                                | 3                         | 1                                | 1                                      | 1              | 2                                | 2                     | 1                           | 3                                  | 3     |
| CO-5 Analyze Spread Spectrum modulation and demodulation technique.  | 2                        | 3                            | 3                                | 3                         | 1                                | 1                                      | 1              | 2                                | 2                     | 1                           | 3                                  | 3     |

Legend: 1 – Low, 2 – Medium, 3 – High

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O) Course Curriculum Map:

| POs & PSOs No.                     | COs No.& Titles  | SOs No.                               | Laboratory Instruction (LI)           | Classroom Instruction (CI)  | Self Learning (SL)                    |
|------------------------------------|--|---------------------------------------|---------------------------------------|---|---------------------------------------|
| PO-1,2,3,4,5,6,7,8,9,10<br>PSO-1,2 | CO-1 Analyze different types of pulse modulation techniques.   | SO1.1, SO1.2<br>SO1.3                 | LE1.1, LE1.2<br>LE1.3                 | Unit 1.0 Pulse Analog Modulation Techniques.<br>1.1, 1.2          | As mentioned in relevant page numbers |
| PO-1,2,3,4,5,6,7,8,9,10<br>PSO-1,2 | CO-2 Test and analyze Pulse Code Modulated and Demodulated signal.   | SO2.1, SO2.2<br>SO2.3, SO2.4<br>SO2.5 | LE2.1, LE2.2<br>LE2.3, LE2.4<br>LE2.5 | Unit 2.0 Pulse Digital Modulation<br>2.1, 2.2, 2.3                |                                       |
| PO-1,2,3,4,5,6,7,8,9,10<br>PSO-1,2 | CO-3 Compute the bandwidth and power requirement of basic digital modulation techniques namely ASK, PSK and FSK. | SO.3.1, SO3.2<br>SO3.3, SO3.4         | LE3.1, LE3.2<br>LE3.3, LE3.4          | Unit 3.0 Digital Band Pass Modulation Techniques<br>3.1, 3.2, 3.3 |                                       |
| PO-1,2,3,4,5,6,7,8,9,10<br>PSO-1,2 | CO-4 Analyze M-ary digital modulation techniques used to increase transmission data rate.                        | SO4.1, SO4.2<br>SO4.3, SO4.4          | LE4.1<br>LE4.2                        | Unit 4.0 Other Digital Modulation Techniques<br>4.1, 4.2, 4.3     |                                       |
| PO-1,2,3,4,5,6,7,8,9,10<br>PSO-1,2 | CO-5 Analyze Spread Spectrum modulation and demodulation technique.  | SO5.1, SO5.2<br>SO5.3, SO5.4          | LE5.1, LE5.2,<br>LE5.3, LE5.4         | Unit 5.0 Spread Spectrum Communication<br>5.1, 5.2, 5.3, 5.4, 5.5 |                                       |

**Legend:** CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

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- A) Course Code : 2028573(028)  
 B) Course Title : Satellite and RADAR Communication  
 C) Pre-requisite Course Code and Title : Communication Systems-I  
 D) Rationale :

In the context of worldwide communication networks Satellite and RADAR communication systems are very important. Satellite communication links enhance capacity to existing communication capability and provide additional alternate route for global communication traffic. Satellite communication involves several aspects of communication technology including both the analog and digital techniques. RADAR is a data communication system and widely used for the detection and location of reflecting objects such as aircraft, ships, spacecraft, vehicles and natural environment. Communication technicians of present industries are therefore must have knowledge to maintain Satellite and RADAR communication systems.

E) Course Outcomes:

CO-1 Identify the functions of various blocks of satellite communication links.

CO-2 Analyze the satellite motion in the orbit.

CO-3 Maintain communication between earth segment and space segment subsystem.

CO-4 Use multiple access techniques for various satellite applications.

CO-5 Analyze functions of RADAR and its applications.

F) Scheme of Studies:

| S. No | Board of Study   | Course Code  | Course Title                          | Scheme of Studies (Hours/Week) |   |   |                      |
|-------|------------------|--------------|---------------------------------------|--------------------------------|---|---|----------------------|
|       |                  |              |                                       | L                              | P | T | Total Credit L+T+P/2 |
| 1     | E&TC Engineering | 2028573(028) | Satellite & RADAR Communication       | 2                              | - | 1 | 3                    |
| 2     | E&TC Engineering | 2028563(028) | Satellite & RADAR Communication (Lab) | -                              | 4 | - | 2                    |

Legend: L - Lecture T - Tutorial P - Practical

G) Scheme of Assessment:

| S. No | Board of Study   | Course Code   | Course Title                          | Schemes of Examination |    |    |           |    |             |
|-------|------------------|---------------|---------------------------------------|------------------------|----|----|-----------|----|-------------|
|       |                  |               |                                       | Theory                 |    |    | Practical |    | Total Marks |
|       |                  |               |                                       | ESE                    | CT | TA | ESE       | TA |             |
| 1     | E&TC Engineering | 2028573 (028) | Satellite & RADAR Communication       | 70                     | 30 | 30 | -         | -  | 130         |
| 2     | E&TC Engineering | 2028563 (028) | Satellite & RADAR Communication (Lab) | -                      | -  | -  | 30        | 50 | 80          |

Legend: ESE - End semester exam CT - Class Test TA - Teachers Assessment

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

Convert unit of the given physical quantity from one unit system to other.



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### CO-1 Identify the functions of various blocks of satellite communication links.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)   | Class room Instruction (CI)  | Self Learning (SL)  |
|--|---|--|---|
| SO1.1 Identify the functions of the given block of satellite link.<br>SO1.2 Identify the applications of the given frequency band used for the satellite communication.<br>SO1.3 Classify different types of satellite.<br>SO1.4 Distinguish type of satellite on the basis of different satellite orbits. | LE1.1 Establish a satellite communication link between transmitter and receiver using tone signal.<br>LE1.2 Establish a direct communication link between transmitter and receiver for the voice signal.<br>LE1.3 Establish an audio-video satellite link between transmitter and receiver. | <b>Unit 1.0 Introduction of satellite communication</b><br>1.1 Need for satellite communication<br>1.2 Brief history of satellite communication<br>1.3 Block diagram of satellite communication link<br>1.4 Frequency allocations for satellite services, uplink and downlink frequency, uplink and downlink frequency bands for various services<br>1.5 Types of satellite: active and passive, synchronous and non synchronous, Low earth orbit(LEO), Medium earth orbit(MEO) and Geostationary earth orbit(GEO) satellites<br>1.6 Satellite communication orbits and its advantages and disadvantages<br>1.7 Present Indian Satellites Communication scenario | <ul style="list-style-type: none"> <li>Summarize advantages and disadvantages of satellite communication.</li> <li>List the uses of different satellite frequency bands.</li> </ul> |

### SW-1 Suggested Sessional Work (SW):

#### a. Assignments:

- Explain characteristics of various frequency bands used for satellite communication.
- Compare merits and demerits of various satellite frequency bands.
- Differentiate between active and passive satellite with example.

#### b. Mini Project:

- Make a model to prove that three communication satellites are sufficient to provide global communication.
- Prepare a report on the Indian satellite programme.

#### c. Other Activities (Specify):

- Make a chart which contains the block diagram of a satellite communication link in detail.
- Prepare PPT on major event occurred in the Indian satellite history.

### CO-2 Analyze the satellite motion in the orbit.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)  | Class room Instruction (CI)  | Self Learning (SL)  |
|--|--|--|---|
| SO2.1 State the significance of Kepler's law of satellite motion.<br>SO2.2 Analyze the given parameter used to establish satellite communication link.<br>SO2.3 Identify the satellite | LE2.1 Measure the propagation delay of the given signal for the established SATCOM link.<br>LE2.2 Install DTH system to get the free DTH signal.<br>LE2.3 Track the dish antenna | <b>Unit 2.0 Orbital parameter and launching of satellite</b><br>2.1 Kepler's law of satellite motion, first, second and third law, Orbital parameters: apogee and perigee heights, Orbit perturbations, effects of a | <ul style="list-style-type: none"> <li>Summarize the properties of following satellite orbits: geostationary orbit, polar orbit, Molniya orbit, Parking orbit,</li> </ul> |

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| Session Outcomes (SOs)   | Laboratory Instruction (LI)                             | Class room Instruction (CI)  | Self Learning (SL)                   |
|--|---|--|--------------------------------------|
| orbit of the satellite for the given orbital parameter.<br>SO2.4 Explain the effect of eclipse on the satellite solar power setup.<br>SO2.5 Describe the different stage of satellite launching. | of DTH system to get the good quality signal reception. | non spherical earth, atmospheric drag<br>2.2 Basic terminologies related to satellite orbits and satellite: latitude, longitude, look angle, elevation angle, station keeping, propagation delay time , velocity and footprint, satellite time period<br>2.3 Effect of eclipse on satellite solar power setup<br>2.4 Mechanics of launching a synchronous satellite in brief | equatorial orbit and inclined orbit. |

### SW-2 Suggested Sessional Work (SW):

#### a. Assignments:

- Explain the Kepler's law of planetary motion and how they are applicable to the geostationary satellite.
- Explain the concept of coverage area and slant range for geostationary satellite.
- Define the term look angles. Explain it with reference to a geostationary satellite.

#### b. Mini Project:

- Prepare an Internet based surveys report on launching of satellite in the geostationary orbit.
- Prepare an Internet based surveys report on various orbit perturbations affecting satellite communication.

#### c. Other Activities (Specify):

- Make a chart to show the various satellite orbits (at least 6).

### CO-3 Maintain communication between earth segment and space segment subsystem.

| Session Outcomes (SOs)  | Laboratory Instruction (LI)  | Class room Instruction (CI)  | Self Learning (SL)                        |
|---|--|--|---|
| SO3.1 Illustrate the orientation of satellite.<br>SO3.2 Explain the functions of telemetry tracking commanding and monitoring of satellite subsystem.<br>SO3.3 Explain the importance of transponder with example.<br>SO3.4 Describe the concept of Earth | LE3.1 Measure the C/N ratio of the typical satellite link at the earth station receiver.<br>LE3.2 Measure the SNR ratio of the typical satellite link at the earth station receiver. | <b>Unit 3.0 Satellite sub-systems</b><br>3.1 Space segment subsystem: Altitude and Orbit Control(AOC) Subsystem, Telemetry Tracking Commanding and Monitoring (TTCM) subsystem, Power and Antenna subsystems,<br>3.2 Transponders<br>3.3 Earth segment subsystem: earth station transmitter and earth station receiver block diagram, function and working | • Summarize the functions of AOC and TTCM |

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| Session Outcomes (SOs)  | Laboratory Instruction (LI) | Class room Instruction (CI)  | Self Learning (SL) |
|---|-----------------------------|--|--------------------|
| segment subsystem.<br>SO3.5 Formulate the link budget calculations for the satellite down link. |                             | 3.4 Link budget calculation: Power flux density, Antenna Gain, Antenna Gain, Transmission Losses, Earth Station Uplink, Satellite Downlink |                    |

### SW-3 Suggested Sessional Work (SW):

#### a. Assignments:

- Describe the functions of altitude and orbit control subsystem.
- Describe telemetry, tracking and command facilities of a satellite communication system.
- List the antenna systems are being used for satellite communication.

#### b. Mini Project:

- Make a model which shows the spin stabilization and three axis body stabilization of satellite.

#### c. Other Activities (Specify):

- Make a chart to describe the block diagram of satellite subsystems.
- Arrange a visit to nearby satellite subsystem station facility.

### CO-4 Use multiple access techniques for various satellite applications.

| Session Outcomes (SOs)  | Laboratory Instruction (LI)   | Class room Instruction (CI)  | Self Learning (SL)   |
|---|---|--|--|
| SO4.1 Explain functions of FDMA, TDMA, CDMA with example.<br>SO4.2 Describe the concept of satellite communication link services.<br>SO4.3 List applications of VSAT.<br>SO4.4 Describe the concept of GPS. | LE4.1 Transmit and receive the Function Generator waveforms through a SATCOM link.<br>LE4.2 Establish a PC-PC satellite communication link using RS 232 port.<br>LE4.3 Test the performance of the given GPS system.<br>LE4.4 Establish the link between the GPS satellite and GPS receiver trainer and measure the latitude, longitude (Position or Location determination) with the help of GPS receiver. | <b>Unit 4.0 Multiple Access Techniques and Satellite Applications</b><br>4.1 Time division multiple access, Frequency division multiple access, Code division multiple access, functions and applications<br>4.2 Satellite services: one way satellite communication link, two way communication satellite link, pre assigned and demand assigned technique<br>4.3 Satellite Applications: Earth observation, remote sensing, Weather forecast, DBS system, VSAT, MSAT, and GPS. | <ul style="list-style-type: none"> <li>Compare function of TDMA, FDMA, and CDMA.</li> <li>List the satellite applications</li> </ul> |

### SW-4 Suggested Sessional Work (SW):

#### a. Assignments:

- Distinguish between pre assigned and demand assigned multiple access techniques. List the relative advantages and disadvantages of both.
- Explain the need of the reference burst in a TDMA system.
- Discuss briefly how demand assignment may be implemented in a TDMA network. What is the advantage of TDMA over FDMA in this respect?

#### b. Mini Project:

- Prepare a report on type of multiple access technique.
- Prepare a model to explain the concept of GPS.

#### c. Other Activities (Specify):

- Demonstrate the functions of GPS with the help of multimedia video.
- Seminar on satellite applications in remote sensing.

### CO-5 Analyze functions of RADAR and its applications.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)   | Class room Instruction (CI)   | Self Learning (SL)  |
|--|---|---|---|
| SO5.1 Illustrate basic functions of RADAR system.                                      | LE5.1 Analyze the RADAR range equation for the given parameters.                        | <b>Unit 5.0 RADAR Systems</b>   | <ul style="list-style-type: none"><li>Differentiate between Pulse RADAR and CW RADAR.</li><li>Explain the peak power and average power of the RADAR signal.</li></ul> |
| SO5.2 Interpret RADAR range equation.  | LE5.2 Determine the velocity of the specified moving object visible in the RADAR range. | 5.1 Introduction: Basic principle of RADAR and SONAR, basic types of RADAR, working of RADAR, applications  |   |
| SO5.3 Define the different RADAR parameters.   | LE5.3 Measure the maximum range of the given Doppler RADAR.                             | 5.2 RADAR range equation and examples, factors affecting maximum range.   |   |
| SO5.4 Identify the different tracking and display technique used for the RADAR system. |   | 5.3 Pulse RADAR: block diagram, RADAR antenna, scanning and tracking methods, display methods<br>5.4 Continuous Wave(CW), Doppler RADAR: Moving target indicator radar, blind speed, frequency modulated CW RADAR |   |

**Legend:** CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others) , LI : Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

### SW-5 Suggested Sessional Work (SW):

#### a. Assignments:

- Define Blind Speed and derive the equation for it.
- Derive RADAR range equation and explain the factors affecting the range of RADAR.

#### b. Mini Project:

- Prepare a chart to represent step by step procedure to measure the velocity of the object range with the help of pulse RADAR.

#### c. Other Activities (Specify):

- Prepare a PPT on types of RADAR (Internet based activity).

**Note:** Performance under Laboratory and Sessional work may appear in more than one COs/SOs.)

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I) Suggested Specification Table (For ESA of Classroom Instruction):

| Unit Number  | Unit Title  | Marks Distribution |           |           | Total Marks |
|--------------|---|--------------------|-----------|-----------|-------------|
|              |   | R                  | U         | A         |             |
| I            | Introduction of satellite communication               | 04                 | 08        | 02        | 14          |
| II           | Orbital parameter and launching of satellite          | 03                 | 06        | 07        | 16          |
| III          | Satellite sub-systems                                 | 04                 | 06        | 06        | 16          |
| IV           | Multiple Access Techniques and Satellite Applications | 02                 | 04        | 06        | 12          |
| V            | RADAR Systems   | 04                 | 04        | 04        | 12          |
| <b>Total</b> |   | <b>17</b>          | <b>28</b> | <b>25</b> | <b>70</b>   |

**Legend:** R: Remember, U: Understand, A: Apply and above

J) Suggested Specification Table (For ESA of Laboratory Instruction\*):

| Laboratory Instruction Number | Short Laboratory Experiment Titles  | Assessment of Laboratory Work (Marks) |     |           |
|-------------------------------|---|---------------------------------------|-----|-----------|
|                               |   | Performance                           |     | Viva-Voce |
|                               |   | PRA                                   | PDA |           |
| LE1.1                         | Establish a satellite communication link between transmitter and receiver using tone signal.  | 15                                    | 10  | 5         |
| LE1.2                         | Establish a direct communication link between transmitter and receiver for the voice signal.  | 15                                    | 10  | 5         |
| LE1.3                         | Establish an audio-video satellite link between transmitter and receiver.   | 15                                    | 10  | 5         |
| LE2.1                         | Measure the propagation delay of the given signal for the established SATCOM link.  | 15                                    | 10  | 5         |
| LE2.2                         | Install DTH system to get the free DTH signal.  | 15                                    | 10  | 5         |
| LE2.3                         | Track the dish antenna of DTH system to get the good quality signal reception.  | 15                                    | 10  | 5         |
| LE3.1                         | Measure the C/N ratio of the typical satellite link at the earth station receiver.  | 15                                    | 10  | 5         |
| LE3.2                         | Measure the SNR ratio of the typical satellite link at the earth station Receiver.  | 15                                    | 10  | 5         |
| LE4.1                         | Transmit and receive the Function Generator waveforms through a SATCOM link.  | 15                                    | 10  | 5         |
| LE4.2                         | Establish a PC-PC satellite communication link using RS 232 port.   | 15                                    | 10  | 5         |
| LE4.3                         | Test the performance of the given GPS system.   | 15                                    | 10  | 5         |
| LE4.4                         | Establish the link between the GPS Satellite and GPS Receiver Trainer and Measure the latitude, longitude (Position or Location determination) with the help of GPS receiver. | 15                                    | 10  | 5         |
| LE5.1                         | Analyze the RADAR range equation for the given parameters.  | 15                                    | 10  | 5         |
| LE5.2                         | Determine the velocity of the specified moving object visible in the RADAR range.   | 15                                    | 10  | 5         |
| LE5.3                         | Measure the maximum range of the given Doppler RADAR.   | 15                                    | 10  | 5         |

\*Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practical's.

**Legend:** PRA: Process Assessment, PDA: Product Assessment

**Note:** Only one experiment has to be performed at the end semester examination of **30** Marks as per assessment scheme.

### K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

### L) Suggested Learning Resources:

#### (a) Books :

| S. No. | Titles  | Author                             | Publisher  | Edition & Year   |
|--------|---|------------------------------------|--|--|
| 1      | Satellite Communication concepts and applications | Rao Raja K. N.                     | PHI learning Private limited ,New Delhi            | 2 <sup>nd</sup> edition 2013<br>ISBN- 978-8120347250   |
| 2      | Satellite Communication                           | Mitra, Monojit                     | PHI learning Private limited ,New Delhi            | ISBN- 978-81-203-2786-3                                |
| 3      | Satellite Communication                           | Katiyar, Sapna                     | Katson publications                                | 3 <sup>rd</sup> edition 2013<br>ISBN-978-93-5014-481-7 |
| 4      | Microwave and RADAR Engineering                   | Gautam, A. K.                      | S K Kataria Publications, New Delhi                | 2012,ISBN: 978-9350141519                              |
| 5      | Microwave and RADAR Engineering                   | Kulkarni, M.                       | Umesh Publications, New Delhi                      | 2009,ISBN978-8188114009                                |
| 6      | RADAR systems and radio aids to navigation        | Sen, A. K. and Bhattacharya, A. B. | Mercury Learning & Information, PVT.LTD. New Delhi | 2017,ISBN: 978-1683921189                              |
| 7      | Fundamentals of Microwave and Radar Engineering   | Sharma, K.K.                       | S.Chand and Company PVT. LTD, New Delhi            | 2011,<br>ISBN:9788121935371                            |

#### (b) Open source software and website address:

1. [https://onlinecourses.nptel.ac.in/noc17\\_ec14/preview](https://onlinecourses.nptel.ac.in/noc17_ec14/preview)
2. <http://www.intelsat.com/wp-content/uploads/2018/04/5941-SatellitePrimer-2017.pdf>
3. [https://www.tutorialspoint.com/satellite\\_communication/](https://www.tutorialspoint.com/satellite_communication/)
4. <http://www.rpsinstitutions.org/downloads/lab%20manual/sclab.pdf> **(LAB)**
5. RADAR:-[www.youtube.com /RADARs](http://www.youtube.com/RADARs)

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## M) List of Major Laboratory Equipment and Tools:

| S. No. | Name of Equipment     | Broad Specifications   | Relevant Experiment Number                         |
|--------|-----------------------|--|--|
| 1.     | Satellite Trainer Kit | Frequency: 100Hz to 1 KHz, 2450-2468 MHz up-linking selectable frequencies, Amplitude: 0V to 1Vpp, Separate terminals provided for different inputs, Power Supply: 230 V AC $\pm 10\%$ , 50/60 Hz, Simultaneous communication of three different signals Communicate Audio, Video, Digital data, PC data, Tone, Voice, function generator waveforms ,USB port for PC communication   | LE1.1,LE1.2,LE1.3, LE2.1, LE3.1 LE3.2,LE4.1, LE4.2 |
| 2.     | DTH trainer kit       | Power supply : 200V to 240v AC, 50Hz,Dish Antenna : 1.5' Aluminum steerable.LNB(Low Noise Block down converter) Input frequency : KU band. Output frequency: 950 to 1450 MHz. Conversion gain: 65 dB. Video Bandwidth: 50 Hz to 5 MHz. Video output level : 1 Vpp. (at 75 ohm load) Video polarity : Normal Audio sub carrier frequency : 5.0 to 8.0 MHz.Uplink satellite : INSAT 4A6  | LE2.2, LE2.3                                       |
| 3.     | GPS trainer kit       | L1 Frequency, C/A code, 51-channel High Sensitivity : Up to -158 dBm tracking, superior urban performances, Low Power Consumption : 55mA @ acquisition, 40mA @ tracking 9600 baud rate Serial Transmission Built in RS232 Level Converter (MAX232) provided in 9 Pin D type connector, Windows based software support GPS Status, Signal Level, Sky chart constellation of SV, In-Built Power Supply of +3.3V/1A with Power ON indication, Input Voltage: 230V AC,User's Manual with sample experiments      | LE4.3, LE4.4                                       |
| 4.     | Radar trainer kit     | Transmitter Frequency : 10 GHz Output Power : 10mW (approximate) Operating Voltage : 8.6V Antenna : Horn Antenna Gain : 16dB Sensitivity : -50 to -70dBm IF Output : Audio range Power Supply : 230V $\pm 10\%$ , 50 Hz Oscilloscope : Real time/Storage mode with FFT analysis Display : Voltage : Vpp Speed : Km/hr, Miles/hr, m/s, rpm Frequency : Hz & kHz Time domain window : Display the Doppler Frequency in Time domain Frequency domain window : Display the Doppler Frequency in Frequency domain | LE5.1, LE5.2, LE5.3                                |
| 5.     | Spectrum analyzer:    | 10MHz – 500MHz   | All  |

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N) Mapping of POs & PSOs with COs:

| Course Outcomes (COs)   | Programme Outcomes (POs) |                              |                                  |                           |                                  |  |                |                                  |                       |                             | Programme Specific Outcomes (PSOs) |       |
|---|--------------------------|------------------------------|----------------------------------|---------------------------|----------------------------------|--|----------------|----------------------------------|-----------------------|-----------------------------|------------------------------------|-------|
|   | PO-1<br>Basic knowledge  | PO-2<br>Discipline knowledge | PO-3<br>Experiments and practice | PO-4<br>Engineering Tools | PO-5<br>The engineer and society | PO-6<br>Environment and sustainability | PO-7<br>Ethics | PO-8<br>Individual and team work | PO-9<br>Communication | PO-10<br>Life-long learning | PSO-1                              | PSO-2 |
| CO-1 Identify the functions of various blocks of satellite communication links. | 1                        | 3                            | 2                                | 2                         | 1                                | 1                                      | 1              | 2                                | 1                     | 2                           | 2                                  | 3     |
| CO-2 Analyze the satellite motion in the orbit.                                 | 2                        | 2                            | 2                                | 2                         | 1                                | 1                                      | 1              | 2                                | 1                     | 2                           | 2                                  | 3     |
| CO-3 Maintain communication between Earth segment and space segment subsystem.  | 1                        | 3                            | 3                                | 3                         | 1                                | 1                                      | 1              | 2                                | 1                     | 2                           | 3                                  | 3     |
| CO-4 Use multiple access techniques for various satellite applications.         | 1                        | 3                            | 2                                | 3                         | 1                                | 1                                      | 1              | 2                                | 1                     | 2                           | 3                                  | 3     |
| CO-5 Analyze functions of RADAR and its applications.                           | 1                        | 3                            | 3                                | 3                         | 1                                | 1                                      | 1              | 3                                | 1                     | 2                           | 3                                  | 3     |

Legend: 1 – Low, 2 – Medium, 3 – High



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## O) Course Curriculum Map:

| POs & PSOs No.                      | COs No.& Titles   | SOs No.                                | Laboratory Instruction (LI)  | Classroom Instruction (CI)  | Self Learning (SL)                    |
|-------------------------------------|---|--|------------------------------|---|---------------------------------------|
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-1 Identify the functions of various blocks of satellite communication links. | SO1.1, SO1.2<br>SO1.3, SO1.4           | LE1.1, LE1.2<br>LE1.3        | Unit 1.0 Introduction of satellite communication<br>1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7 | As mentioned in relevant page numbers |
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-2 Analyze the satellite motion in the orbit.                                 | SO2.1, SO2.2,<br>SO2.3, SO2.4<br>SO2.5 | LE2.1<br>LE2.2<br>LE2.3      | Unit 2.0 Orbital parameter and launching of satellite<br>2.1, 2.2, 2.3, 2.4           |                                       |
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-3 Maintain communication between Earth segment and space segment subsystem.  | SO3.1, SO3.2<br>SO3.3, SO3.4,<br>SO3.5 | LE3.1<br>LE3.2               | Unit 3.0 Satellite sub-systems<br>3.1, 3.2, 3.3, 3.4                                  |                                       |
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-4 Use multiple access techniques for various satellite applications.         | SO4.1, SO4.2<br>SO4.3, SO4.4           | LE4.1, LE4.2<br>LE4.3, LE4.4 | Unit 4.0 Multiple Access Techniques and Satellite Applications<br>4.1, 4.2, 4.3       |                                       |
| PO-1,2,3,4,5,6, 7,8,9,10<br>PSO-1,2 | CO-5 Analyze functions of RADAR and its applications.                           | SO5.1, SO5.2<br>SO5.3, SO5.4           | LE5.1<br>LE5.2<br>LE5.3      | Unit 5.0 RADAR Systems<br>5.1, 5.2, 5.3, 5.4  |                                       |

**Legend:** CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

# Chhattisgarh Swami Vivekanand Technical University, Bhilai

## Diploma in Electronics and Telecommunication Engineering

Semester -V

- A) Course Code : 2028574(028)
- B) Course Title : Consumer Electronics
- C) Pre-requisite Course Code and Title : Electronic Devices and Circuit, Analog Electronics, Communication System
- D) Rationale :  
Installed and troubleshoot various consumer electronics appliances is the one of the important job roles of the diploma engineers. Upon completion of the course, the student will develop skills to analyze and test the performance of various consumer electronics appliances like different types of Audio & Video Systems, Office & Home automation appliances and advance consumer electronic gadgets used in our day-today activities.

E) Course Outcomes:

- CO-1 Maintain various types of audio systems.
- CO-2 Maintain TV System.
- CO-3 Maintain various electronic home Appliances.
- CO-4 Maintain various electronic office appliances.
- CO-5 Maintain electronics blocks used in automobile.

F) Scheme of Studies:

| S. No | Board of Study   | Course Code  | Course Title               | Scheme of Studies (Hours/Week) |   |   |                      |
|-------|------------------|--------------|----------------------------|--------------------------------|---|---|----------------------|
|       |                  |              |                            | L                              | P | T | Total Credit L+T+P/2 |
| 1     | E&TC Engineering | 2028574(028) | Consumer Electronics       | 2                              | - | 1 | 3                    |
| 2     | E&TC Engineering | 2028564(028) | Consumer Electronics (Lab) | -                              | 2 | - | 1                    |

Legend: L - Lecture T - Tutorial P - Practical

G) Scheme of Assessment:

| S. No | Board of Study   | Course Code   | Course Title               | Schemes of Examination |    |    |           |    |             |
|-------|------------------|---------------|----------------------------|------------------------|----|----|-----------|----|-------------|
|       |                  |               |                            | Theory                 |    |    | Practical |    | Total Marks |
|       |                  |               |                            | ESE                    | CT | TA | ESE       | TA |             |
| 1     | E&TC Engineering | 2028574 (028) | Consumer Electronics       | 70                     | 30 | 30 | -         | -  | 130         |
| 2     | E&TC Engineering | 2028564 (028) | Consumer Electronics (Lab) | -                      | -  | -  | 30        | 50 | 80          |

Legend: ESE - End semester exam CT - Class Test TA - Teachers Assessment

H) Course-Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Session Outcomes (SOs) and finally Course Outcomes (COs) upon the completion of course.

# Chhattisgarh Swami Vivekanand Technical University, Bhilai

## Diploma in Electronics and Telecommunication Engineering

Semester -V

### CO-1 Maintain various types of audio systems.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)   | Class room Instruction (CI)  | Self Learning (SL)   |
|--|---|--|--|
| SO1.1 Classify different types of microphone.<br>SO1.2 Classify different types of loudspeakers.<br>SO1.3 Describe the working principal of collar mic.<br>SO1.4 Describe the working principal of Bluetooth enabled speaker amplifier.<br>SO1.5 Describe the Block diagram and working of the given section of PA system. | LE1.1 Test the frequency response performance of the given microphone.<br>LE1.2 Measure audio intensity level with the help of suitable audio level meter.<br>LE1.3 Test the frequency response performance of different types of loudspeakers.<br>LE1.4 Installed and run the given PA system.<br>LE1.5 Installed and test the car audio system.<br>LE1.6 Connect the wireless microphone with the wi-fi enable PA system. | <b>Unit 1 Audio Systems</b><br>1.1 Microphones: characteristics of microphones; types of microphones: Carbon Microphone, Crystal Microphone, Moving Coil (Dynamic) Microphone, Capacitor Microphone, Tie Clip Microphone, Wireless/cordless Microphone, Working principle & construction, bluetooth enabled microphone<br>1.2 Loudspeaker: Ideal Loudspeaker, Basic Loudspeaker, types of loudspeakers: crystal, electrostatic, permanent magnet; Woofers; tweeters; hi-fi system; multi-speaker system, working principle & construction, Bluetooth enabled speaker<br>1.3 PA system: introduction, Basic building blocks: microphone, speaker, and amplifier. PA system characteristics, speaker matching, wi-fi enable PA system. | <ul style="list-style-type: none"> <li>Describe the step by step procedure to use a PA system</li> <li>Describe the functions of various front panel settings of car audio system.</li> <li>List the various file formats used for audio data .</li> </ul> |

### SW-1 Suggested Sessional Work (SW):

#### a. Assignments:

- Explain the different quality parameters of microphones.
- Calculate the power output of the given speaker if the resistance of the microphone is given.

#### b. Mini Project:

- Prepare a chart to describe the working function of Microphone.
- Prepare a chart to show the different blocks of the CAR audio system.

#### c. Other Activities (Specify):

- Identify different type of computer networks used in real life situations.
- Present seminar on wired and wireless communication medium.

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## Diploma in Electronics and Telecommunication Engineering

Semester -V

### CO-2 Maintain TV System.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)   | Class room Instruction (CI)   | Self Learning (SL)   |
|--|---|---|--|
| SO2.1 Describe scanning process used in the TV, with the help of suitable sketch.<br>SO2.2 Differentiate between hue, brightness, saturation, luminance and chrominance.<br>SO2.3 Describe the properties of various components of composite video signal with suitable sketch.<br>SO2.4 Describe working of DTH receiver.<br>SO2.5 Compare the LED ,LCD and plasma TV receivers.<br>SO2.6 Describe the working of the smart TV with the help of suitable block diagram. | LE2.1 Install indoor and outdoor unit of the given DTH System.<br>LE2.2 Operate digital TV trainer kit and observe wave form at the output of the various sections.<br>LE2.3 Test the various functionality of smart TV.<br>LE2.4 Test the functionality and performance of LED TVs.<br>LE2.5 Compare performance parameters of at least three brands television receivers. | <b>Unit 2 Television System:</b> Evolution of TV System, Definitions: Scanning, picture element, Aspect ratio, Persistence of vision & flicker, Resolution, Video bandwidth, Interlaced scanning, attributes of color, luminance, and chrominance, Camera & TV receiver, Television standard used in India.<br>Basic concept on Plasma Display, LCD display, LED display.<br>Basic concept of IPTV, Mobile TV, Smart TV.<br>Video interface: Composite, Separate Video, Digital Video Interface, SDI, HDMI.<br>Direct to Home System (DTH): Introduction & Block Diagram. Concept of set top box, indoor and outdoor units. | <ul style="list-style-type: none"> <li>Identify various interfaces available in digital TV receivers.</li> <li>Distinguish between the principles of IPTV and Mobile TV</li> </ul> |

### SW-2 Suggested Sessional Work (SW):

#### a. Assignments:

- Describe the working principal of Plasma TV.
- Explain the critical performance parameters of smart TV.

#### b. Mini Project:

- Prepare a internet based survey report on the smart TV of various brands(at least 5 brands).

#### c. Other Activities (Specify):

- Collect information about Set top box used for cable TV at home.

### CO-3 Maintain various electronic home Appliances.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)  | Class room Instruction (CI)   | Self Learning (SL)   |
|--|--|---|--|
| SO3.1 Explain working principle of Microwave oven with the help of sketches.<br>SO3.2 Describe working of Washing machine with sketches.<br>SO3.3 Discuss electronic control blocks of Air conditioner and | LE3.1 Test the performance of functional blocks and front panel controls of microwave oven.<br>LE3.2 Test the performance of functional block and front panel controls of washing machine.<br>LE3.3 Demonstrate the operation of air conditioning system | <b>Unit 3.0 Home Appliances:</b><br>Microwave oven: Block diagram and working principle, LCD Timer with Alarm, Single Chip Controller and other important technical specification.<br>Washing Machine: basic parts, Electronic Controller for Washing Machine and other technical specifications. | <ul style="list-style-type: none"> <li>Describe the functions of Front Panel of Washing Machine.</li> <li>Explain the need of inverter Air-conditioners.</li> <li>Describe the functions of smart</li> </ul> |

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| Session Outcomes (SOs) | Laboratory Instruction (LI)      | Class room Instruction (CI)   | Self Learning (SL) |
|------------------------|----------------------------------|---|--------------------|
| Refrigerators.         | with the help of remote control. | Air Conditioning & Refrigeration: Block diagram and working principle, functions, indoor and outdoor units and other important technical specifications | Refrigerator       |

### SW-3 Suggested Sectional Work (SW):

#### a. Assignments:

- Suggest the specification of Air-conditioner as per the given application area/room size.

#### b. Mini Project:

- Compare the technical specifications of various types of washing machine.
- Prepare an exclusive list of latest consumer electronics appliances used for various applications.

#### c. Other Activities (Specify):

- Conduct market survey for latest home appliances and compare specifications of reputed brands and prepare a report.
- Arrange a demonstration to show the trouble shoot the washing machine of any latest brand.
- Show the animation video to represent the function of smart refrigerator.

### CO-4 Maintain various electronic office appliances.

| Session Outcomes (SOs)   | Laboratory Instruction (LI)   | Class room Instruction (CI)   | Self Learning (SL)   |
|--|---|---|--|
| SO4.1 Describe the basic principle of Xerographic process.<br>SO4.2 Explain each block/sections of CCTV Camera.<br>SO4.3 Describe functions of the each block of Biometric attendance system.<br>SO4.4 Classify biometric system | LE4.1 Test the functionality of the given type of Xerox machine.<br>LE4.2 Install and Test the output of CCTV system.<br>LE4.3 Add and remove the extra Cameras in the existing CCTV system.<br>LE4.4 Install and test the finger impression based biometric attendance system. | <b>Unit 4.0 Office Appliances:</b><br>4.1 Xerography: Xerographic Process, Extension to Dynamic Copier, working, technical specifications.<br>4.2 CCTV camera: Introduction, Applications for CCTV, Multi Camera System With Video Recorder (Block Diagram Only)<br>4.3 Biometric Attendance System Block diagram, working, technical specification, types. | <ul style="list-style-type: none"> <li>List the applications of CCTV camera system.</li> <li>Compare the functionality of different brands of Xerox machine features</li> <li>Compare the types of CCTV camera systems.</li> </ul> |

### SW-4 Suggested Sectional Work (SW):

#### a. Assignments:

- Prepare a chart to show the wiring diagram of a CCTV camera system containing six cameras installed at different locations.
- List the common problems arise in the xerox machine.

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**b. Mini Project:**

- i. Prepare an internet-based survey report on different types of biometric system.

**c. Other Activities (Specify):**

- i. Conduct market survey for latest office appliances and compare specifications of reputed brands and prepare a report.

**CO-5 Maintain general electronics systems used in automobile.**

| Session Outcomes (SOs)   | Laboratory Instruction (LI) | Class room Instruction (CI)  | Self Learning (SL) |
|--|-----------------------------|--|--------------------|
| SO5.1 List the in- car computer applications.<br>SO5.2 Describe the functions of ABS and electronic central locking system used in auto bile.<br>SO5.3 Describe the working of battery operated vehicles.<br>SO5.4 Explain the functions of GPS enable mobile system |                             | <b>Unit 5.0 Electronics for Automobiles:</b><br>5.1 In-Car computers: applications, Electronic ignition, electronic ignition and door lock system, Anti-Lock Braking System, Dashboard functions and circuitry, other digital displays, vehicle proximity Detection System ,Car navigation System, charging function and battery operated vehicle .<br>5.2 Automobile Battery Hybrid Synergy Vehicles Electronic Power Steering and breakingsystem, Parking Assistant System, Immobilizer system, electronic fault indication mechanism/system, RFID based maintenance and repair assistance, fast tage service for toll collection, car communication syste/GPS based communication system. |                    |

**Legend:**CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning

**SW-5 Suggested Sectional Work (SW):**

**a. Assignments:**

- i. Describe the function of GPS connected in the car.

**b. Mini Project:**

- i. Prepare a report on the common electronic vehicle available in the market.

**c. Other Activities (Specify):**

- i. Make visit to service centers of gadgets covered in curriculum and if possible work there for some days on voluntarily basis during holidays.

**Note:** Performance under Laboratory and Sessional work may appear in more than one COs/SOs.

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## I) Suggested Specification Table (For ESA of Classroom Instruction):

| Unit Number  | Unit Title                                  | Marks Distribution |           |           | Total Marks |
|--------------|---|--------------------|-----------|-----------|-------------|
|              |   | R                  | U         | A         |             |
| I            | Basics of Computer Networking               | 5                  | 7         | 2         | 14          |
| II           | Reference Models for Network Implementation | 4                  | 5         | 7         | 16          |
| III          | Line Coding and Switching                   | 4                  | 5         | 5         | 14          |
| IV           | Network Protocol and Applications           | 2                  | 5         | 6         | 13          |
| V            | Networking Parameters and Devices           | 3                  | 5         | 5         | 13          |
| <b>Total</b> |   | <b>18</b>          | <b>27</b> | <b>25</b> | <b>70</b>   |

**Legend:** R: Remember, U: Understand, A: Apply and above

## J) Suggested Specification Table (For ESA of Laboratory Instruction\*):

| Laboratory Instruction Number | Short Laboratory Experiment Title   | Assessment of Laboratory Work (Marks) |     |           |
|-------------------------------|---|---------------------------------------|-----|-----------|
|                               |   | Performance                           |     | Viva-Voce |
|                               |   | PRA                                   | PDA |           |
| LE1.1                         | To plot frequency response of a given microphone.   | 15                                    | 10  | 5         |
| LE1.2                         | Measure audio intensity level with the help of suitable audio level meter.                  | 15                                    | 10  | 5         |
| LE1.3                         | To plot frequency response of different types of loudspeakers                               | 15                                    | 10  | 5         |
| LE1.4                         | To establish PA system  | 15                                    | 10  | 5         |
| LE2.1                         | Installation of DTH System.   | 15                                    | 10  | 5         |
| LE2.2                         | Operate digital TV trailer kit and observe wave form.                                       | 15                                    | 10  | 5         |
| LE2.3                         | Verify the performance of LED TVs. Compare performance parameters of at least three brands. | 15                                    | 10  | 5         |
| LE3.1                         | To study functional block diagram and front panel controls of microwave oven                | 15                                    | 10  | 5         |
| LE3.2                         | To study functional block diagram and front panel controls of washing machine               | 15                                    | 10  | 5         |
| LE3.3                         | To demonstrate the operation of air conditioning system                                     | 15                                    | 10  | 5         |

\* Assessment rubric, process and product check list with rating scale need to be prepared by the course wise teachers for each experiment for conduction and assessment of laboratory experiments /practicals

**Legend :** PRA: Process Assessment, PDA : Product Assessment

**Note :** Only one experiment has to performed at the end semester examination of 30 Marks as per assessment scheme

## K) Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Industrial visits
6. Industrial Training
7. Field Trips
8. Portfolio Based Learning
9. Role Play
10. Demonstration
11. ICT Based Teaching Learning (Video Demonstration, CBT, Blog, Face book, Mobile)
12. Brainstorming
13. Others

### L) Suggested Learning Resources:

#### (a) Books :

| S. No. | Titles   | Author                        | Publisher                           | Edition & Year         |
|--------|--|-------------------------------|-------------------------------------|------------------------|
| 1      | Consumer Electronics   | Bali S.P.                     | Pearson Education                   | 1 <sup>st</sup> , 2008 |
| 2      | Audio video systems : principle practices & troubleshooting          | Bali R and Bali S.P.          | Khanna Book Publishing Co. (P) Ltd. | Latest edition         |
| 3      | Standard handbook of Audio engineering                               | Whitaker Jerry & Benson Blair | McGraw-Hill Professional            | Latest edition         |
| 4      | Audio video systems  | Gupta R.G.                    | Tata Mcgraw Hill, New Delhi, India  | Latest edition         |
| 5      | Monochrome And Colour Television                                     | Gulati R.R.                   | New age international Publication   | Latest edition         |
| 6      | Modern Television Practice: Transmission, Reception And Applications | Gulati R.R.                   | New age international Publication   | Latest edition         |

#### (b) Open source software and website address:

1. [www.nptel.ac.in](http://www.nptel.ac.in)
2. [www.youtube.com](http://www.youtube.com)
3. [https://en.wikipedia.org/wiki/List\\_of\\_video\\_connectors](https://en.wikipedia.org/wiki/List_of_video_connectors)
4. [www.learnerstv.com](http://www.learnerstv.com)
5. Joshi S. & Maskara S.L. " Evolution and Future Generation of TV" May 2012.  
(<https://www.researchgate.net/publication/267406737>)
6. [https://www.cctv-information.co.uk/i/Introduction\\_to\\_Closed\\_Circuit\\_Television](https://www.cctv-information.co.uk/i/Introduction_to_Closed_Circuit_Television)

### M) List of Major Laboratory Equipment and Tools:

| S. No. | Name of Equipment   | Broad Specifications  | Relevant Experiment Number        |
|--------|---------------------|---|-----------------------------------|
| 1      | DSO                 | 50 MHz, with all accessories and operation manual   | LE1.1                             |
| 2      | Digital Multi-meter | 3 1/2 digit display, 9999 counts digital multimeter measures: $V_{ac}$ , $V_{dc}$ ( 1000V max) , $A_{dc}$ , $A_{ac}$ (10 amp max) , Resistance ( 0 - 100 M $\Omega$ ) , Capacitance measurement, component tester) with working manual  | All                               |
| 3      | DB Meter            | 20 to 140 dB (single range),<br>External power: 9 to 14V DC at 250mA  | LE1.2, LE1.3                      |
| 4      | Continuity Tester   | Power Supply : 230 V ac +/- 10% AND or OR 12 V DC, 800 mA., One to One Tester : Number of circuits to be tested 32 / 48 / 96 circuits i.e. 64 / 96 / 192, points as per model. Last circuit to be tested, programmable by user. Refer document for circuit connections, Test Parameters : 5V DC @ current in mA , Tester I/Os : 37 pin D RA F, PCB mountable connectors, 32 points in each connector, "from" and "to" . | LE3.1, LE3.2, LE4.1, LE4.2, LE5.3 |



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N) Mapping of POs & PSOs with COs:

| Course Outcomes (COs)                               | Programme Outcomes (POs) |                              |                                  |                           |                                  |  |                |                                  |                       |                             | Programme Specific Outcomes (PSOs) |       |
|---|--------------------------|------------------------------|----------------------------------|---------------------------|----------------------------------|--|----------------|----------------------------------|-----------------------|-----------------------------|------------------------------------|-------|
|   | PO-1<br>Basic knowledge  | PO-2<br>Discipline knowledge | PO-3<br>Experiments and practice | PO-4<br>Engineering Tools | PO-5<br>The engineer and society | PO-6<br>Environment and sustainability | PO-7<br>Ethics | PO-8<br>Individual and team work | PO-9<br>Communication | PO-10<br>Life-long learning | PSO-1                              | PSO-2 |
| CO-1 Maintain various types of audio systems.       | 1                        | 3                            | 3                                | 3                         | 3                                | 1                                      | 2              | 3                                | 3                     | 3                           | 3                                  | 3     |
| CO-2 Maintain TV System                             | 1                        | 3                            | 3                                | 3                         | 3                                | 2                                      | 2              | 2                                | 3                     | 3                           | 3                                  | 3     |
| CO-3 Maintain various electronic home Appliances.   | 1                        | 3                            | 3                                | 3                         | 3                                | 1                                      | 2              | 3                                | 3                     | 3                           | 3                                  | 3     |
| CO-4 Maintain various electronic office appliances. | 1                        | 3                            | 3                                | 3                         | 3                                | 1                                      | 2              | 3                                | 3                     | 3                           | 3                                  | 3     |
| CO-5 Maintain electronics blocks used in automobile | 1                        | 3                            | 3                                | 3                         | 3                                | 1                                      | 2              | 3                                | 3                     | 3                           | 3                                  | 3     |

Legend: 1 – Low, 2 – Medium, 3 – High

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## O) Course Curriculum Map:

| POs & PSOs No.                             | COs No.& Titles                                     | SOs No.   | LaboratoryInstruction(LI)                        | Classroom Instruction (CI)      | Self Learning (SL)                          |
|--|---|---|--|---------------------------------|---|
| PO-1,2,3,4,5,6,<br>7,8,9,10<br><br>PSO-1,2 | CO-1 Maintain various types of audio systems.       | SO1.1,<br>SO1.2<br>SO1.3,<br>SO1.4,<br>SO1.5                  | LE1.1 ,LE1.2<br>LE1.3 ,LE1.4<br>LE1.5 ,LE1.6     | Unit 1.0<br>1.1, 1.2, 1.3       | As mentioned<br>in relevant<br>page numbers |
| PO-1,2,3,4,5,6,<br>7,8,9,10<br><br>PSO-1,2 | CO-2 Maintain TV System                             | SO.2.1,<br>SO.2.2,<br>SO.2.3,<br>SO.2.4,<br>SO.2.5,<br>SO.2.6 | LE2.1, LE. 2.2,<br>LE2.3, LE2.4,<br>LE2.5, LE2.6 | Unit 2.0<br>2.1,2.2,2.3,2.4,2.5 |   |
| PO-1,2,3,4,5,6,<br>7,8,9,10<br><br>PSO-1,2 | CO-3 Maintain various electronic home Appliances.   | SO.3.1<br>SO3.2<br>SO3.3                                      | LE3.1<br>LE 3.2<br>LE3.3                         | Unit 3.0<br>3.1, 3.2, 3.3       |   |
| PO-1,2,3,4,5,6,<br>7,8,9,10<br><br>PSO-1,2 | CO-4 Maintain various electronic office appliances. | SO4.1,<br>SO4.2<br>SO4.3,<br>SO4.4                            | LE4.1, LE4.2,<br>LE4.3, LE4.4                    | Unit 4.0<br>4.1, 4.2, 4.3       |   |
| PO-1,2,3,4,5,6,<br>7,8,9,10<br><br>PSO-1,2 | CO-5 Maintain electronics blocks used in automobile | SO5.1,<br>SO5.2,<br>SO5.3,<br>SO5.4                           | LE5.1, LE5.2,<br>LE5.3, LE5.4                    | Unit 5.0<br>5.1, 5.2            |   |

**Legend:** CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), LI: Laboratory Instruction (Includes Practical performances in Laboratory, Workshop, field or other locations using different instructional strategies) SL: Self Learning.

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## Diploma in Electronics and Telecommunication Engineering

Semester -V

- A) Course Code : 2028565(028)  
B) Course Title : Industrial Training  
C) Pre- requisite Course Code and Title :  
D) Rationale :

With the advancement in technology and industry 4.0, we need to prepare our young Indian technical talent to meet the present demand. Our diploma passouts are either supposed to work as supervisor in the industries or start their own enterprise, hence upon the completion of diploma programme, they need to be adequately equipped with knowledge, skills and attitude required by the world of work in their relevant field. To attain this, students need to be sent for industrial visit and industrial training during the course of study. With these provision of industrial exposures relevant practical and professional skills are developed in the students and as a result of this students are readily employed and widely accepted by cross section of the industries, even sometimes during such training itself.

Series of continues interactions with the industry personnel are required to be done for planning and arranging and also effectively implementing such exposures.

- E) **Course Outcomes:** After undergoing the industrial visit, industrial training and internship the students will be able to -

CO-1 Appreciate the importance of industrial visit, industrial training and internship for gaining direct practical skills on their relevant domain area.

CO-2 Comprehend the comprehensive view of industry or world of work in terms of its layout, management, culture, hierarchy, discipline, safety norms, different department/sections, quality control/assurance in processes, services and products, demonstration and operation of specific equipment/machinery, rules and procedures etc.

- F) **Scheme of Studies:**

| S. No | Board of Study   | Course Code   | Course Title        | Scheme of Studies (Hours/Week) |   |   |                        |
|-------|------------------|---------------|---------------------|--------------------------------|---|---|------------------------|
|       |                  |               |                     | L                              | P | T | Total credit L+T+(P/2) |
| 1     | E&TC Engineering | 2028565 (028) | Industrial Training | -                              | 2 | - | 1                      |

**Legend:** L - Lecture      T - Tutorial      P - Practical

- G) **Scheme of Assessment:**

| S. No | Board of Study   | Course Code   | Course Title        | Schemes of Examination |    |    |           |    |             |
|-------|------------------|---------------|---------------------|------------------------|----|----|-----------|----|-------------|
|       |                  |               |                     | Theory                 |    |    | Practical |    | Total Marks |
|       |                  |               |                     | ESE                    | CT | TA | ESE       | TA |             |
| 1     | E&TC Engineering | 2028565 (028) | Industrial Training | -                      | -  | -  | 50        | 70 | 120         |

**Legend:** ESE - End semester exam      CT - Class Test      TA - Teachers Assessment

Guidelines to teachers for Industrial Visit, Industrial Training and Internship are given below:

### H) Guidelines to Teachers for arranging Industrial Visit :

#### 1. Rationale :

During implementation of the curriculum, industrial exposure in the form of industrial visit is very important for developing and reinforcing many concepts and principles and also to get an idea to understand the industrial environment, working culture and latest developments in relevant field and many other aspects of the industries, where diploma holders are going to be absorbed. Students also get exposed to the different kinds of problems which can be brought into the institutional laboratories or workshop. Planning before industrial visit and Industrial tour is essentially required to be done or effective implementation of the same.

#### 2. Planning for industrial visit :

During industrial visit of students to develop certain expected outcomes, many dimensions or aspects of industries need to be understood. The major dimensions or aspects of industry's visit which may be taken care of during the industrial visit are as below –

- Layout of different Departments, Sections of Industry, stores, entry and exit etc.

| S.N  | Major Dimensions /Aspects of Industrial Visit   |
|------|---|
| I.   | Layout of different Departments, Sections of Industry, stores, entry and exit etc.  |
| II.  | Display of Quotations in the Industry   |
| III. | Display of Charts on - <ul style="list-style-type: none"><li>• Systems of Industry</li><li>• Procedures/Rules/standards</li><li>• Hierarchy at Industries</li><li>• Products &amp; Services</li><li>• Targets</li><li>• Safety Precautions/Norms</li><li>• Flow diagrams of different process</li><li>• Other Aspects</li></ul> |
| IV.  | Demonstration of Specific Equipment, not available in the Institute or Department or even the Demonstration of Performance of Specific Experiment.  |
| V.   | Demonstration of latest Engineering Tools or Techniques or Software's or Procedures   |

Assessment rubric may be prepared by the implementing teachers in advance for assessing the students on various dimensions of industrial visit.

#### 3. Major outcomes expected to be attained and assessed :

Outcomes expected from the industrial visit should be clearly defined and briefed to the students. Evaluation criteria for assessing students, need to be prepared for different outcomes set, during the planning stage. The list of major outcomes expected to be attained are –

- Development and reinforcement of Basic knowledge
- Development and reinforcement of Engineering knowledge through reinforcement of concepts or principles
- Outcome attainment through content beyond syllabus
- Engineering and Society
- Environment & Sustainability
- Communication ability
- Industrial System and its development
- Safety Awareness

- Systematic Operations and Productions
- Quality control
- Management of work place and work force
- Development of positive attitude
- Work culture/Quality Culture
- Development of Professional Ethics
- Industrial Management
- Systematic planning, Implementation & Evaluation
- Use of engineering tools, techniques, softwares and Procedures
- Development of Lifelong learning skills

It is important to note that outcomes attained during industrial visit are at the awareness level only.

### I) Guidelines to Teachers for arranging Industrial Training:

#### 1. Rationale :

Apart from arranging industrial visit, organizing industrial training of students is essentially required to be done during implementation of the curriculum to improve the quality of our young diploma engineering students and to enhance the prospects of employability. After undergoing industrial training, students get the direct exposure to the world of work in their relevant field. They get hands on experience in the industries. The need to be given opportunity to undergo training in relevant industry for minimum two weeks and it is recommended that it should be mandatory for all the programmes running in the institute. The industrial training period may vary from 2 weeks to 6 months depending upon the requirement of that programme.

The programmes, where there is provision of industrial training during the semester are termed as sandwich programmes. Many of the programmes have industrial training at the end of last semester or sometimes a full semester is dedicated for industrial training.

#### 2. Planning for Industrial Training :

Following points need to be planned and briefed by the teachers to the students before proceeding for industrial training. Student should take into consideration these points and carry the relevant format/data/log book with them.

- Objectives /Purposes of the industrial training
- Outcomes targeted before proceeding to industrial training.
- Pre-requisite knowledge or skills required to be developed in the students in the form of demonstration or classroom sessions.
- Identification and planning for demonstration of any equipment or experiments, concepts, under the content beyond syllabus.
- Preparation of database of nearby relevant industries.
- Good rapport need to be developed and maintained with the industries by the teachers, so that the students are ultimately benefitted by the industrial training.
- Industrial policy of the state also need to be taken care of while planning of industrial training
- For assessing the students on various dimensions of industrial training, assessment rubric may be prepared by the implementing teachers in advance.
- Following formats need to be developed by the teachers and briefed to the students before proceeding to industrial training –
  - Formats of observations on layout, ambience, and work culture to be developed, and briefed to the students.

- Formats of outcome attainment, related to observation on relevant technical area also need to be developed by the teachers and briefed to the students.
- Formats and contents of report writing and presentation.
- Formats and contents on assessment of industrial training.
- Continuous observation formats on many points such as behavioral aspects related to soft skills development such as initiativeness, observation, notes taking skills, inquisitiveness, obedience, sincerity, follow the instructions, positive attitude and many other aspects.
- Formats of Assessment Rubric on different parameters of both behavioral aspects and technical aspects of the programme.

### 3. Actions to be taken by the Students and Teachers :

Students are sent to Industrial training after briefing on various aspects. During industrial training, observational skills in students are required to a great extent -

- Students need to be alert, meticulous and record the data, as briefed to them before the industrial training.
- Record of observations on safety precaution to be followed, any special point during performance and handling of equipment, performance on technical aspects and other related aspects need to be taken care of.
- Continuous observation, monitoring and assessment on various behavioral and performance of technical aspects of each student need to be critically observed and recorded by the teachers using different assessment tools.

### 4. Post Training Assessment :

The students need to be assessed on report writing, presentation and interpretation of data recorded, on various dimensions, planned and performed, after the industrial training. The actions are required to be taken for assessment during report writing, analysis, interpretation, presentation of data and its assessment.

### 5. Major outcomes expected to be attained and assessed :

The following learning outcomes are expected to be developed during the industrial training. This will lead to attainment of COs, POS and PSOs.

- Development and Reinforcement of Basic Knowledge/concepts
- Development and Reinforcement & Engineering Knowledge i.e operations, performance, maintenance, demonstrations of specific skills relevant to the content of the programme.
- Experiment and practice – Development of experimental practical skills and technical skills relevant to the course programme.
- Development of learning to learn skills and life long teaching skills for latest advancement in technology.
- Development of positive attitude, professional ethics and etiquettes.
- Development of skills for individual and team work during performance and otherwise.
- Maintaining Business Secrecy
- Development of Communication Skills
- Ability to follow the instructions
- Ability to follow the safety precautions
- Ability to supervise the task
- Ability to coordinate with subordinates and higher ups
- Development of Interpersonal skills
- Environmental Consciousness and Sustainability
- Development of Observational Skills

- Time Management
- Self discipline
- Integrity
- Development of generic skills such as pro-activeness, commitment
- Development of Problem Solving abilities
- Achievement of target

### J) Guidelines to Teachers for arranging Internship :

#### 1. Rationale :

The concepts of internship is the need for the development of outcomes based in the students. It encourages on the job-training, practice, feedback and reinforcement of concepts and principles. During internship students are exposed to variety of task/problems/assignments which enhances the exposure of students to cross section of different real situations. Continuous feedback on the job helps in sharpening of the outcomes to be attained in the relevant field.

#### 2. Planning for Internship :

The advantages of providing internshala platform to the students are enormous. Some of these are :

- Free access to 4<sup>th</sup> Lakhs internships (both part-time and full time).
- A chance to earn a certificate and a stipend.
- Additional 10% discount on all Internshala training to students.
- The T&P official of every college will who receive a monthly performance report of their students on Internshala.
- Once the institutions are registered with the Internshala. Registration is done through the website [internshala.com/i/register-rgpv](http://internshala.com/i/register-rgpv). Details of students (name, e-mail & phone no.) are uploaded in an excel sheet. Internshala will create an account for all the students so that they can apply for internship. The registration is free of cost.

For assessing the students on various dimensions of internship, assessment rubric may be prepared by the implementing teachers in advance

#### 3. Major outcomes expected to be attained and assessed :

The following learning outcomes/skills are expected to be developed through internship. This will lead to attainment of COs, POS and PSOS.

- Development and Reinforcement of Basic Knowledge/concepts
- Development and Reinforcement & Engineering Knowledge i.e operations, performance, maintenance, demonstrations of specific skills relevant to the content of the programme.
- Experiment and practice – Development of experimental practical skills and technical skills relevant to the course programme.
- Development of learning to learn skills and lifelong learning skills for latest advancement in technology.
- Development of positive attitude ethics values and etiquettes.
- Development of skills for Individual and Team work during performance and otherwise.
- Maintaining Business Secrecy
- Development of Communication Skills
- Ability to follow the instructions

- Ability to follow the safety precaution
- Ability to supervise the task
- Ability to coordinate with subordinates and higher ups
- Development of Interpersonal skills
- Environmental Consciousness and Sustainability
- Development of Observational Skills
- Time Management
- Self discipline
- Integrity
- Development of generic skills such as pro-activeness, commitment
- Development of Problem Solving abilities
- Achievement of target

### **K) Initiatives by Govt. of India and other Agencies :**

#### **1. Initiatives by Govt. of India, GOI**

##### **a. Initiatives by Ministry of Skills Development and Entrepreneurship**

Many efforts are initiated by different agencies in this direction as per our Prime Minister's Skills Development Mission. Make in India, Skills India etc are such initiatives taken by ministry for the benefit of the students.

##### **b. Initiatives by Ministry of HRD, Govt. of India**

- I. Ministry of HRD, Government of India is providing students a platform to inculcate a culture of product innovation and a mindset of problem solving to solve some of pressing problems solving to solve some of pressing problems we face in our daily lives through Smart India Hackathon (SIH) 2019.

In SIH-2019, the students would also have the opportunity to work on challenges faced within the private sector organizations and create world class solutions for some of the top companies in the world, thus helping the private sector hire the best minds from across the nation. The team size for participation in one team will be 8 (6 Students + 2 Mentors). 50 Teams will be selected for the final Hackathon. The prize will be a cash prize for each rank with following distribution criteria for the top three teams ranging from Rs. 50,000 to 1,00,000/-.

- II. **Internshala** :Internshala is India's largest internship and training platform where more than 80,000 companies look for interns in various profiles (Engineering, management, media, arts etc.) AICTE has also partnered with Internshala for providing internship opportunities to every students in AICTE approved colleges. This facility is created to provide a platform for hands on experience to the our future technicians on the relevant industries. With this experience, they are updated with the latest advances in their field of work.

Government of India through, AICTE is engaged in promoting the concept of industrial training through its various scheme, such as Internshala. The teachers now have the responsibility to understand in depth and implement such schemes in the institution for the benefit of students. At institute level also, there is need to develop policy for sending the students for industrial training.

##### **c. Initiatives by Ministry of Labour and Employment, Govt. of India**

Ministry of Labour and Employment, Government of India launched a National ICT based job portal known as National Career Service (NCS) portal to connect the opportunities with the aspirations of youth. This portal facilitates registration of job seekers, job providers, skill providers. Career counselors, etc. The portal provides job matching services in a highly transparent and user friendly manner. These



facilities along with career counseling content are delivered by the portal through multiple channels like career centres, mobile devices, CSCs, etc.

The portal provides information on over 3000 career options from 53 key industry sectors. Job seekers also have access to industry trends in a user friendly way. The NCS portal links job-seekers, employers, counselors and training providers all through Aadhaar-based authentication. Registration to NCS portal is online and free of charge. The salient feature of NCS portal includes the following :

- Career counseling and Guidance
- Enabling Skill Development
- Empowering Job seekers to find the right Job
- Enabling employers to pick the right talent
- Enhancing capabilities of students through training

Information's related to Job Fairs/Placements

### d. Initiatives by Telecom Sector Skill Council (TSSC)

TSSC has taken a step towards fulfilling the emerging requirements of the industry by partnering with key stakeholders in order to bring the latest content to the forefront. TSSC have got into partnership with All India Council for Technical Education (AICTE) for summer internship programme and various other MNCs to impart Skilling in new emerging technologies. Some of the prime courses in new emerging technologies being offered by TSSC in addition to TSSC Qualification packs are as under :

- Artificial Intelligence & Data Science
- Cyber Security
- Internet of Things
- Android
- AR/VR

In addition to this certain courses on life skills/soft skills, employability related skills are also planned for the students such as

- Problem solving and analytic
- Communication skills
- Lifelong learning
- Behavioral Skills
- Professional Behavioral etc.

The main objectives of TSSC are as follows

- Bridge the gap and enhance employability of our students
- Training young minds towards 21<sup>st</sup> Century skills assisting industry cross-sector
- Meet the needs of school leavers and graduates, employers, government educational institutions and society.
- Address the need for quality, skill training for human resources to complement the large goal of accomplishing the include growth.
- Address the limited capacity of skills development facilities in India
- To develop extensive placement linkages with employers in all sectors to provide gainful entry-level employment opportunities to youth undergoing the skill training.
- Industry participation in developing the skill training solutions to address critical skill gaps by standardization of training content, delivery and assessment process o improve overall competitiveness of the industry.

## 2. Initiatives by other agencies

### a. Initiatives by Engineering Council of India (ECI)

(ECI has also taken initiatives to organize series of interactive workshops to update and apprise the students about the products and services being offered by respective corporate house. This interaction will definitely bring the institute and industry closer and help in planning for effective implementation of industrial training.

### b. Others

Many public sector and private organizations are also contributing to the course of quality improvement in technical education system by way of arranging industrial visit of providing industrial training to the students as a part of their corporate social responsibility and also for the growth of technical education system of the country.

### L) Initiatives to be taken by State Technical University/Board/Institutions.

- State Technical University/Board have to sign MOU with Internshala, partner of AICTE, with the aim of providing students with professional experience in the form of internship. For registration of students at college level for Internshala platform, visit of website [addressinternshala.com/i/register-rgpv](http://addressinternshala.com/i/register-rgpv) is suggested for uploading the details (Name, e-mail address & phone number compulsory) in an excel sheet. Internshala will create an account for all the students so that they can apply for internship. The registration is free of cost.
- Programme wise Industries Bank of nearby industries at state level and national level need to be created for useful interaction with details of content e-mail addresses phonenumbers and areas of expertise.
- Institute may take initiative to facilitate the registration of students at National Career service ([www.ncs.gov.in](http://www.ncs.gov.in)) portal and ensure the compliance of above directive in your institute.
- Institute should encourage and facilitate the registration of team of students for Smart India Hackathon-2019 at [www.sih.gov.in](http://www.sih.gov.in) portal and other similar websites.
- After careful curriculum analysis and also identifying the learning gaps, an action plan for effective implementation of the course need to be prepared based on the area of industries. This would help the teachers to decide the particular industry to be visited for exposing to specific content area or specific outcomes to be attained.
- Frequent Industry – Institute meet may be arranged on different topics for mutual benefit.
- List of a directory of industrial experts may be prepared for inviting them for seeking their expertise.
- Guidelines/policy for sending students to industrial training/internship must be prepared by the university for effective implementation of the industrial training/internship.
- TOT programmes on orientation of arranging industrial visit, training should be arranged for teachers implementing the same.
- MOU between University and Industry need to be signed for -
  - Industry collaboration for student/faculty empowerment
  - Partnership with industry on curriculum implementation.
  - Demonstrating and performing practical performances to students.
  - Providing technical work force for industrial production.
  - Corporate support to Academia through various resources.
- Establishment of training and placement cell at each institute level.
- Employability Enhancement initiatives need to be taken by CSVTU for arranging campus placement at CSVTU level/institute level or through open campus.

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