Curriculum of Diploma Programme

in

Electronics & Communication

Engineering

Department of Science, Technology and Technical Education (DSTTE), Govt. of Bihar

State Board of Technical Education(SBTE), Bihar

Semester – III
Teaching & Learning Scheme

Course Codes	Category of course	CourseTitles	Teaching & Learning Scheme (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
			L	T				
2421301	**PCC**	**Analog Electronics** (ELX, ELX (R))	03	-	04	02	09	06
2421302	**PCC**	**Measuring Instruments and Sensors** (ELX, ELX (R))	03	-	04	02	09	06
2421303	**PCC**	**Digital Electronics** (ELX, ELX (R))	03	-	04	02	09	06
2421304	**PCC**	**Principles of Electronic Communication**	03	-	04	02	09	06
2421305	**PCC**	**Electronic Simulation Software Practice** (ELX, ELX (R))	-	-	04	02	06	03
2421306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	02	02	04	02
2400308	**NRC**	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	01	-	-	-	01	01
Total			**13**	**-**	**22**	**12**	**47**	**30**

Note: Prefix will be added to course code if applicable (T for Theory Paper, P for Practical Paper and S for Term Work)

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

Semester - III
Assessment Scheme

Course Codes	Category of course	Course Titles	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2421301	**PCC**	**Analog Electronics** (ELX, ELX (R))	30	70	20	30	20	30	200
2421302	**PCC**	**Measuring Instruments and Sensors** (ELX, ELX (R))	30	70	20	30	20	30	200
2421303	**PCC**	**Digital Electronics** (ELX, ELX (R))	30	70	20	30	20	30	200
2421304	**PCC**	**Principles of Electronic Communication**	30	70	20	30	20	30	200
2421305	**PCC**	**Electronic Simulation Software Practice** (ELX, ELX (R))	-	-	20	30	20	30	100
2421306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	10	15	10	15	50
2400308	**NRC**	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	25	-	25	-	-	-	50
Total			**145**	**280**	**135**	**165**	**110**	**165**	**1000**

Note: Prefix will be added to course code if applicable (T for Theory Paper, P for Practical Paper and S for Term Work)

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

A) Course Code : **2421301(T2421301/P2421301/S2421301)**

B) Course Title : Analog Electronics (ELX, ELX (R))

C) Pre- requisite Course(s) : Basic Electronics, Electric circuit and machine

D) Rationale :

An analog electronics course for the students of a diploma in electronics engineering program is crucial for several reasons. Analog electronics provides a foundational knowledge of electronic circuits and devices, which is essential for designing and analyzing circuits. It is also highly relevant to various industries and provides students with practical hands-on experience, critical thinking skills, and problem-solving skills. Additionally, an analog electronics course prepares students for further study in more advanced areas of electronics engineering. As such, the analog electronics course is an integral part of the diploma in the electronics engineering curriculum, providing students with the necessary skills and knowledge to succeed in the electronics industry.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of the following course outcomes by the learners. For this, the learners are expected to performvarious activities related to three learning domains (Cognitive, Psychomotor, and Affective) in the classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Measure the stability of a transistor for different types of biasing methods.

CO-2 Use a transistor as a low-frequency amplifier.

CO-3 Use MOSFET for various applications.

CO-4 Describe the working principle and characteristics of SCR, DIAC, and TRIAC.

CO-5 Use BJT as a feedback amplifier and waveform generator.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	2	-	2	-	-	-		
CO-2	3	3	-	2	-	-	-		
CO-3	3	-	-	2	-	-	-		
CO-4	3	1	-	2	-	-	-		
CO-5	3	3	-	3	-	3	2		

Legend: High (3), Medium (2), Low (1), and No mapping (-)

***** PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Teaching & Learning Scheme (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2421301	Analog Electronics	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem-based learning, etc. to deliver theoretical concepts)

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SL: Self Learning, MOOCs, spoken tutorials, online educational resources, etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of the teacher to ensure the outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2421301	Analog Electronics	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in the classroom (includes class test, mid-term test, and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro-projects, industrial visits, self-learning, any other student activities, etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignments, micro-projects, seminars, and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria for internal as well as external assessment may vary as per the requirement of the respective course. For valid and reliable assessment, the internal faculty should prepare a checklist & rubrics for these activities.

I) 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), Term Work (TW), and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to the attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020-related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS), and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2421301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the need for Transistor Biasing. TSO 1b. Calculate the Current and Voltage in different types of Biasing circuit TSO 1c. Calculate the Stability factor of different Types of Biasing circuits. TSO 1d. Explain the effect of temperature on transistor parameters TSO 1e. Compare the Stability factors of different types of circuits used for transistor biasing.	**Unit-1.0 Transistor Biasing** 1.1 Need for Transistor Biasing 1.2 Transistor parameters Considered for basing 1.3 Stabilization and Stability Factor 1.4 Effects of Temperature on I_{CBO} 1.5 Transistor Biasing Methods: Base Resistor Method, Emitter Bias, Voltage Divider, Collector to base Feedback resistor biasing.	**CO1**
TSO2.a Define Gain, Frequency response, Bandwidth, Input impedance and Output impedance of an amplifier. TSO2.b Sketch the D.C. equivalent circuit of the transistor amplifier and describe it. TSO2.c Calculate the voltage gain of CE Amplifier. TSO2.d Calculate the Input and Output Impedance, voltage gain, current gain, and stability factor of CE Amplifier. TSO2.e Describe the effect of cascading on amplifier parameters. TSO2.f Compare the Capacitive and Direct coupled amplifier.	**Unit-2.0 Single Stage and Multistage Transistor Amplifier** 2.1 Single Stage Transistor amplifier parameters 2.2 D.C and A.C Equivalent Circuits of Transistor Amplifier 2.3 Load Line Analysis 2.4 Voltage Gain of CE Transistor Amplifier, without C_E, Input and Output Impedance of CE Amplifier. 2.5 Voltage Gain Stability 2.6 Multistage Amplifier: Effect of R_S, R_i, and Interstage Loading Coupling of transistor amplifiers, Capacitor coupling, Direct coupled amplifier 2.7 Amplifier Gain in Decibels, frequency response, and bandwidth	**CO1, CO2**
TSO3.a Describe the working of JFET & MOSFET with the help of suitable sketch. TSO3.b Draw and explain the input-output, transfer characteristics of JFET & MOSFET. TSO3.c Calculate the drain current and V_{DS} voltage of the given circuit. TSO 3d. Describe any one application of UJT. TSO 3e. List the applications (any three) of JFET, MOSFET & UJT.	**Unit-3.0 Field Effect Transistors (FET), JFET and MOSFET** 3.1 Introduction to JFET: Symbol, Construction, and Working Principles of JFET, Input-output and transfer characteristics of JFET, 3.2 Introduction to MOSFET: Symbol, Types, D-MOSFET and E-MOSFET, construction, and working principles of MOSFET, Input-output and transfer characteristics of MOSFET, applications of MOSFET 3.3 Introduction to UJT: Equivalent circuit, operation, and its applications (relaxation oscillator).	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO4.a Interpret the characteristics of an SCR, DIAC & TRIAC. TSO4.b Explain how SCR works as a switch. TSO4.c Compare SCR, DIAC, TRIAC & MOSFET.	**Unit-4.0 Power Electronics Devices** 4.1 SCR: Construction, symbol, working, characteristics, and applications 4.2 DIAC: Construction, symbol, working, and characteristics, application as a bidirectional switch 4.3 TRIAC: Construction, symbol, working, and characteristics	**CO4**
TSO5.a Explain the effect of feedback on different amplifier parameters. TSO5.b Determine the input & output impedance of the given feedback amplifier. TSO5.c Calculate the voltage gain of the positive and negative feedback amplifier TSO5.d Describe the working principle of a given Oscillator circuit.	**Unit-5.0 Feedback Amplifiers and Oscillators** 5.1 Feedback: Negative and Positive Feedback, Derivation of Gain, Advantages, Dissaving's and Application of Feedback 5.2 Feedback Topology: Voltage series, current Series, Voltage Shunt, Current shunt 5.3 Calculate Gain, Input and Output Impedance 5.4 Comparison of Topology on different Parameters 5.5 Oscillator: Working principle, Different Types of Oscillators, RC Phase shift Oscillator, Wein Bridge Oscillator, Hartley Oscillator, Colpitt's Oscillator, Crystal Oscillator	**CO5**

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical:P2421301

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO1.1 Measure the terminal currents & terminal voltages of the voltage divider bias circuit of BJT	1.	Build a voltage divider bias circuit and measure the terminal currents & terminal voltages of the voltage divider bias circuit of BJT.	CO1
LSO2.1 Measure the terminal currents & terminal voltages of the self-biased circuit.	2.	Build a self-bias circuit and measure the terminal currents & terminal voltages of the self-biased circuit.	CO1
LSO3.1 Test the Input and output characteristics of the CE amplifier.	3.	Build the CE amplifier circuit and verify the Input and output characteristics.	CO2
LSO4.1 Test the Input and output characteristics of the CC amplifier	4.	Build the CC amplifier circuit and verify the Input and output characteristics.	CO2
LSO5.1 Test the performance of the CB amplifier.	5.	Build the CB amplifier circuit and verify the Input and output characteristics.	CO2
LSO6.1 Measure the output voltage and output Current.	6.	Build the CE amplifier circuit and measure the voltage gain & current gain of the CE amplifier.	CO2
LSO7.1 Measure the Output voltage and output Current.	7.	Construct the CC amplifier circuit and measure the voltage & current gain of the CC amplifier.	CO2
LSO8.1 Measure the output voltage, output current.	8.	Construct the CB amplifier circuit and measure the voltage & current gain of the CE amplifier.	CO2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO9.1 Measure the frequency of the RC-coupled CE amplifier.	9.	Build the RC-coupled CE amplifier circuit and measure the operating frequency of the RC-coupled CE amplifier.	CO2
LSO10.1 Interpret the Input and output characteristics.	10.	Build the CD amplifier circuit and test the performance of the Input and output characteristics of the CD amplifier.	CO3
LSO11.1 Interpret the V-I characteristics of TRIAC.	11.	Test the performance of TRIAC.	CO4
LSO12.1 Interpret the V-I characteristics of SCR.	12.	Test the performance of SCR	CO4
LSO13.1 Measure the frequency of the Wien-bridge Oscillator circuit.	13.	Build the Wien-bridge oscillator circuit on a breadboard and measure the operating frequency of oscillation of the Wien-Bridge oscillator.	CO5

L) Suggested Term Work and Self-Learning: S2421301 Some sample suggested assignments, micro-projects and otheractivities are mentioned here for reference.

a. Assignments:

1. Calculate the circuit's performance of a common emitter amplifier in terms of its gain, input, output impedance, and frequency response.
2. Calculate the effect of feedback on the amplifier's performance in terms of its gain, stability, and distortion.
3. As per the given transistor's specifications, students have to calculate the values of resistors needed for biasing the BJT in a common emitter amplifier.

b. Micro Projects:

1. Build an Audio amplifier.
2. Construct a doorbell using a Transistor.
3. Build a Simple Class A Amplifier for radio application.
4. Electronics water level controller device.

c. Other Activities:

1. Seminar Topics:

   - Renewable energy using a photovoltaic cell.
   - Li-Fi and its application

2. Visits: Visit nearby electronic shops/industries having sufficient electronic equipment.
3. Self-Learning Topics:

   - h-Parameter.
   - MOSFET as a capacitor and resistor

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use the appropriate assessment strategy and its weightage in theory, laboratory, and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	10%	15%	-	-	20%	20%
CO-2	10%	20%	10%	25%	-	10%	20%
CO-3	15%	20%	15%	25%	33%	15%	20%
CO-4	30%	20%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

***:** Other Activities include self-learning, seminar, visits, surveys, product development, software development etc.

****:** Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- In the case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided among all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises questions related to the achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: The specification table represents the reflection of sample representation of the assessment of the cognitive domain of the full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Bipolar Junction Transistor (BJT)	9	CO1	7	2	2	3
Unit-2.0 Bipolar Junction Transistor (Cont.)	11	CO1, CO2	14	4	4	6
Unit-3.0 Field Effect Transistors (FETs)	7	CO3	14	4	4	6
Unit-4.0 Power Electronics	10	CO4	14	4	4	6
Unit-5.0 Feedback Amplifiers and Oscillators	11	CO5	21	6	7	8
Total	**48**	**-**	**70**	**20**	**21**	**29**

Note: Similar table can also be used to design class/mid-term/ internal question papers for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Build a voltage divider bias circuit and measure the terminal currents & terminal voltages of the voltage divider bias circuit of BJT.	CO1	30	60	10
2.	Build a self-bias circuit and measure the terminal currents & terminal voltages of the self-biased circuit.	CO1	40	50	10
3.	Build the CE amplifier circuit and Plot the Input and output characteristics.	CO2	30	60	10
4.	Build the CC amplifier circuit and Plot the Input and output characteristics.	CO2	30	60	10
5.	Build the CB amplifier circuit and Plot the Input and output characteristics.	CO2	30	60	10
6.	Build the CE amplifier circuit and measure the voltage gain & current gain of the CE amplifier.	CO2	30	60	10
7.	Construct the CC amplifier circuit and measure the voltage gain & current gain of the CC amplifier.	CO2	30	60	10
8.	Construct the CB amplifier circuit and measure the voltage gain & current gain of the CE amplifier.	CO2	40	50	10
9.	Build the RC-coupled CE amplifier circuit and measure the operating frequency of the RC-coupled CE amplifier.	CO2	40	50	10
10.	Build the CD amplifier circuit and test the performance of the Input and output characteristics of the CD amplifier.	CO3	40	50	10
11	Test the performance of TRIAC.	CO4	40	50	10
12	Test the performance of SCR	CO4	40	50	10
13	Build the Wien-bridge oscillator circuit on a breadboard and measure the operating frequency of oscillation of the Wien-Bridge oscillator.	CO5	40	50	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to beprepared by the course teacher for each experiment/practical to assess the student's performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them areImproved Lectures, Tutorial, Case Methods, Group Discussions, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Labs, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs, etc.

Q) List of Major Laboratory Equipment, Tools, and Software:

S. No.	Name of Equipment, Tools, and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	C.R.O.	Dual Channel 100MHz	All
2.	Function generator	100MHz Function & Arbitrary Generator,500MSa/s-DG4102	3,4,5,6,7,8,9
3.	Dual Power supply	Digital Dual Output DC Power Supply, Input Voltage: 230 V Ac, Output Voltage: 0 To 128 V	All
4.	Bread Board	MB 102 Breadboard with Power Supply Module, Jumper Wires, Battery Clip,830 & 400 tie-Points	All
5.	Digital Multimeter	DM-86 Digital Multimeter AC Frequency Response: 40-400Hz Low Battery Display: Approx. < 7.5V	All

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Analog Circuits	A.K. Maini	Khanna Publishing House Ed. 2018 (ISBN: 978-93-86173-584)
2.	Electronic Devices and Circuits	S. Salivahanan and N. Suresh Kumar	McGraw Hill Education; Fourth edition (1 July 2017), ISBN: 978-9339219505
3.	Electronics Devices and circuit theory	Boyestad & Nash-elsky	Pearson Education India; 11 edition (2015), ISBN: 978-9332542600
4.	Electronic Principles	Albert Malvino & David Bates	Tata McGraw Hill Publication 2010 ISBN: 978-0070634244
5.	Electronics Devices & Circuits	Jacob Millman	McGraw Hill Education; 4 edition (2015) ISBN: 978-9339219543

(b) Online Educational Resources:

1. https://www.youtube.com/watch?v=HQ9pHFvq5do&list=PLm_MSClsnwm8EdADExAUnwdEM51R3Yhfc
2. https://www.youtube.com/watch?v=xhn188JafbM&list=PL350612601E2DBFDE
3. https://youtube.com/playlist?list=PLMksOeFI6x39hw7SMZp9xb_Np0ClVPzpA

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

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A) Course Code : **2421302(T2421302/P2421302/S2421302)**

B) Course Title : Measuring Instruments and Sensors (ELX, ELX (R))

C) Pre- requisite Course(s) : Basic Electrical Engineering, Basic Electronics Engineering

D) Rationale :

The electronics engineering diploma engineers are expected to measure and calibrate precisely different types of measuring instruments used in various industries. They are also expected to automate the systems in industries using sensors, transducers, and actuators. This course is the core course, demands a better understanding of the construction, materials used and principle of operation and safe operating procedures of various types of measuring instruments. The students after passing this course should possess the knowledge, skills set not only to use appropriate measuring instruments correctly and precisely but also should be able to maintain the same.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor, and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Apply the basics of measurement to a given electrical system.
- **CO-2** Use analog and digital meters for measuring various electrical parameters safely and precisely.
- **CO-3** Measure basic electrical quantities (like resistance, capacitances, Inductances) using calibrated DC and AC bridges.
- **CO-4** Use CRO and DSO measuring specified parameters precisely.
- **CO-5** Test the functionality of different types of sensors and transducers.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	2	3	2	-	1	2		
CO-2	3	2	2	2	-	-	3		
CO-3	3	3	3	2	3	-	3		
CO-4	3	3	3	2	-	3	3		
CO-5	3	3	3	3	3	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2421302	Measuring instruments and sensor	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture(L), Tutorial(T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

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C: Credits= (1x CI hours) + (0.5 x LI hours) + (0.5xNotionalhours)

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H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work& Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2421302	Measuring Instrument and Sensors	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, microprojects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) 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), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2421302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe different performance characteristics of an instrument. TSO 1b. Identify different type of errors in measurement (with calculation). TSO 1c. List the types of errors present in the measurement. TSO 1d. Explain the importance of calibration.	**Unit-1.0 Basics of Measurement and Instrumentation** 1.1 Static and dynamic characteristics of measurement 1.2 Accuracy, resolution, precision, sensitivity 1.3 Types of error and its analysis 1.4 Calibration: Need and procedure of calibration	**CO1**
TSO 2a. Describe the construction and working principle of a given instrument. TSO 2b. Determine resolution, sensitivity, and accuracy of the given instrument. TSO 2c. Convert the PMMC instrument into a DC ammeter for the given range. TSO 2d. Convert the PMMC instrument into DC voltmeter for the given range. TSO 2e. Describe the working of the given type of ohmmeter and AC voltmeter.	**Unit-2.0 Analog and Digital Meters** 2.1 Classification of instrument, Indicating and display device: D'Arsonval galvanometer, PMMC, moving iron, electro-dynamo meter type, thermal type, rectifier type 2.2 Analog and Digital meters: Types of analog and digital meters, voltmeter, ammeter, multirange voltmeter and ammeter, ohm meter	**CO2**
TSO 3a. Classify the resistance measurement (low, medium and high). *TSO 3b.* Describe the working principle of potentiometer and the given type of bridges. *TSO 3c.* Determine the unknown resistance/capacitance/inductance/ frequency using the given bridge.	**Unit-3.0 Potentiometer and Bridges** 3.1 Classification and measurement of resistance (Low, Medium, & High) 3.2 Basic DC slide wire potentiometer 3.3 DC Bridges: Wheatstone and Kelvin's Double Bridge 3.4 AC Bridges: Maxwell's Bridge, Hay's Bridge, Anderson Bridge, De-Sauty's Bridge, Wien's Bridge	**CO3**
TSO 4a. Draw the block diagram of cathode ray oscilloscope. TSO 4b. Describe the working of the given block of oscilloscope (with sketch). TSO 4c. Describe the procedure to measure the given parameter using CRO. TSO 4d. Describe the working of the signal/function generator with the help of suitable block diagram. TSO 4e. Describe the procedure to measure the electrical quantities of the given types of	**Unit-4.0 Oscilloscope and Function Generator** 4.1 CRO: Block diagram of CRO, CRT, Vertical deflection system and Horizontal deflection system, Need of Delay line, Time base generator, amplitude and frequency measurement using CRO, Lissajous pattern for phase and frequency measurement. 4.2 DSO: Block Diagram, functions, working principles, front panel operations, and applications 4.3 Function generator: Block diagram of a function generator, working of each block, front panel	**CO4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
signal using the relevant test and measuring instrument. TSO 4e. Select CRO/DSO and function generator for the specified measurement with justification.	controls and operations, application of function generator	
TSO 5a. Differentiate working of sensor, transducer and actuator. *TSO 5b.* Select relevant transducer for the given application with justification. *TSO 5c.* Differentiate the features of transducers and sensors for the given quantity measurement. *TSO 5d.* Describe working principle of LVDT/RVDT. *TSO 5e.* Describe the working principle of given type of thermal/ optical/ magnetic/ IR and electric sensors with the help of suitable sketch.	**Unit-5.0 Transducers and Sensors** 5.1 Basic Definition, difference between Transducer, Sensors, & Actuators 5.2 Transducer: Need of transducer, types of transducers and their applications: Primary, secondary, Active, Passive, Analog, Digital, Resistive, Capacitive, Inductive (LVDT, RVDT), Piezoelectric transducer, strain gauge 5.3 Sensors: Thermal, optical, magnetic, Proximity sensor, and IR Sensors. 5.4 Temperature measurement: Thermistor, RTD, Thermocouple 5.5 Pressure measurement: Bourdon tube, Diaphragm 5.6 Humidity measurement: Hygrometer, pH Measurement	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical:P2421302

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 Calibrate the give an ammeter and voltmeter.	1.	• Calibrate the given ammeter with a standard meter. • Calibrate the given voltmeter with a standard meter.	CO1
LSO 2.1 Convert the given galvanometer into ammeter and voltmeter.	2.	Conversion of galvanometer into ammeter and voltmeter.	CO1, CO2
LSO 3.1 Measure voltage, current and resistance using analog and digital multimeter.	3.	Use analog & digital meter for measurement of voltage, current, & resistance of the given circuit.	CO2
LSO 4.1 Calibrate a given ammeter using DC slide wire Potentiometer.	4.	Calibrate an ammeter using DC slide wire potentiometer.	CO2, CO3
LSO 5.1 Determine effect of over loading on the performance of a multimeter.	5.	Perform a test to determine the multimeter's performance under the overloading condition	CO2
LSO 6.1 Measure low resistance value using Kelvin's double bridge.	6.	Use Kelvin's double bridge for measurement of low resistance	CO3
LSO 7.1 Measure medium resistance value using Wheatstone bridge or Voltmeter-Ammeter method or Ohm meter.	7.	Measure medium resistance using Wheatstone bridge or Voltmeter-Ammeter method or Ohmmeter	CO3
LSO 8.1 Measure inductance of given inductor using the appropriate bridge	8.	• Use AC bridge (Maxwell's Bridge, Hay's Bridge for measurement of inductance. • Compare the result obtained through	CO3, CO4

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		AC bridge with measurement by DSO.	
LSO 9.1. Measure capacitance of given capacitor using appropriate AC bridge	9.	Use AC bridge (Anderson Bridge, De-Sauty's Bridge, Wien's Bridge) for measurement of Capacitance. Compare the result obtained through AC bridge with measurement by DSO.	CO3, CO4
LSO 10.1 Measure frequency of given circuit using appropriate bridge.	10.	• Use AC (Wine bridge) bridge for measurement of frequency. • Compare the result obtained through AC bridge with measurement by DSO	CO3, CO4
LSO 11.1 Measure voltage, frequency, time period, & phase angle using CRO.	11.	Use CRO/DSO kit and function generator to measure voltage, frequency, time period & phase angle.	CO4
LSO 12.1 Measure position and small displacement using LVDT.	12.	Use LVDT for displacement measurement.	CO5
LSO 13.1 Measure angular displacement using RVDT.	13.	Measure angular displacement using RVDT.	CO5
LSO 14.1 Test the performance of temperature sensor *LSO 14.2* Select the temperature sensors as per the application.	14.	Test the performance and functionality of the given temperature sensor.	CO5
LSO 15.1 Measure strain using strain gauge.	15.	Use strain gauge to measure strain/force of the given system.	CO5
LSO 16.1 Use proximity sensor for the given applications.	16.	Test the functionality of a given type of Proximity sensor (Inductive, Capacitive, Optical and Ultrasonic).	CO5

L) Suggested Term Work and Self Learning: S2421302 Some sample suggested assignments, micro project and otheractivities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

1. Prepare a chart depicting the function of various front panel control of CRO.
2. Prepare a chart depicting the function of various front panel control of DSO.
3. Enlist the sensors used in general industry and their functions.
4. Enlist the sensors used for consumer and industrial applications.
5. Enlist the sensors which are used in sustainable development.

b. Micro Projects:

1. Dismantle a PMMC/MI meter to identify the parts and its material.
2. Use CRO to measure various parameters of a given waveform.
3. Display the temperature and humidity of the measurement lab using sensor and controller board.
4. Display the wind speed of college campus using Anemometer and controller board.
5. Measure the water level of hostel tank using relevant sensor and controller board.

c. Other Activities:

1. Seminar Topics:
   - Virtual Instrumentation
   - Fibre optic sensor and its applications in instrumentation and measurement
   - Robotic sensors
   - Vibration measurement and monitoring system
   - Environmentally Friendly and Biodegradable Ultrasensitive Piezoresistive Sensors for Wearable Electronics Applications
   - Sensor based drone for pollutants detection in eco-friendly cities

2. Visits: Visit nearby toolroom/industry. Prepare report of visit with special comments on measuring techniques and measuring instruments and sensors/Transducers used

3. Self-Learning Topics:
   - Smart sensors
   - Bio and Nano sensors
   - Automobile sensors
   - Sensors used in a process industry

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	-	-	-	10%	20%
CO-2	20%	20%	-	25%	15%	20%	20%
CO-3	20%	20%	-	-	15%	25%	20%
CO-4	25%	25%	50%	25%	15%	20%	20%
CO-5	25%	25%	50%	50%	55%	25%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given is approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Basics of Measurement and Instrumentation	6	CO1	7	2	2	3
Unit-2.0 Analog and Digital Meters	10	CO2	14	4	4	6
Unit-3.0 Potentiometer and Bridges	10	CO3	14	4	4	6
Unit-4.0 Oscilloscope and Function Generator	10	CO4	17	5	5	7
Unit-5.0 Transducers and Sensors	12	CO5	18	5	5	8
Total	**48**	**-**	**70**	**20**	**20**	**30**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	• Calibrate the given ammeter with a standard meter. • Calibrate the given voltmeter with a standard meter.	CO1	50	40	10
2.	Conversion of galvanometer into ammeter and voltmeter.	CO1, CO2	50	40	10
3.	Use analog & digital meter for measurement of voltage, current, & resistance of the given circuit.	CO2	50	40	10
4.	Calibrate an ammeter using DC slide wire potentiometer.	CO2, CO3	50	40	10
5.	Perform a test to determine the multimeter's performance under the overloading condition.	CO2	50	40	10
6.	Use Kelvin's double bridge for measurement of low resistance.	CO3	50	40	10
7.	Measure medium resistance using Wheatstone bridge or Voltmeter-Ammeter method or Ohmmeter.	CO3	50	40	10
8.	• Use AC bridge (Maxwell's Bridge, Hay's Bridge for measurement of inductance. • Compare the result obtained through AC bridge with measurement by DSO.	CO3, CO4	50	40	10
9.	• Use AC bridge (Anderson Bridge, De-Sauty's Bridge, Wien's Bridge) for measurement of Capacitance. • Compare the result obtained through AC bridge with measurement by DSO.	CO3, CO4	50	40	10
10.	• Use AC (Wine bridge) bridge for measurement of frequency. • Compare the result obtained through AC bridge with measurement by DSO.	CO3, CO4	50	40	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
11.	Use CRO/DSO kit and function generator to measure voltage, frequency, time period & phase angle.	CO4	50	40	10
12.	Use LVDT for displacement measurement.	CO5	50	40	10
13.	Measure angular displacement using RVDT.	CO5	50	40	10
14.	Test the performance and functionality of the given temperature sensor.	CO5	50	40	10
15.	Use strain gauge to measure strain/force of the given system.	CO5	50	40	10
16.	Test the functionality of a given type of Proximity sensor (Inductive, Capacitive, Optical and Ultrasonic).	CO5	50	40	10

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

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Galvanometer, resistance, bread board	Measurement ranges: ± 35 µA; Scale division: 1 µA; Internal resistance: 1000 Ohm	2
2.	Voltmeter, Ammeter, Multimeter, Function generator	Voltmeter - i/p, range is from ± 1 V to ± 1000 V, The accuracy is about ± 1 percent for a 3 digit digital voltmeter and ± 0.002 percent for a 6 digit digital voltmeter Ammeter – 0 to 50A	All
3.	Potentiometer	• 1st Dial 17 x 0.1V = 1.7 V • 2nd Dial (slide wire) 100x0.001 = 0.1V	4
4.	Various bridge kits	Operating voltage – 220 V, Kalvin bridge, wine bridge, Hays bridge, Wheatstone, Anderson's	6,7,8,9,10
5.	DSO, CRO	DSO frequency range - 0 to 100MHz CRO frequency range - 0 to 75MHz	8,9,10,11
6.	LVDT kit	LVDT displacement range – 10inch	12
7.	RTD, Thermistor kit	RTD temp. range - -250 to 1000°c Thermistor temp. range- −100 °C to 300 °C	14
8.	Strain gauge kit	Strain Gauge range - 5000µstrain	15

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	A Course in Electrical and Electronics Measurements& Instrumentation	Sawhny A.K.	Dhanpat Rai & Sons, India ISBN:9788188458936
2.	Electronic Instrument & Measurement Technique	Cooper W.D.	Prentice Hall International, India ISBN:9780132516860
3.	Electronic Instrumentation and Measurements	Kalsi H.S.	McGraw Hill Education (India) Private Limited, Noida, UP
4.	A Text Book of Electrical Technology Vol-I (Basic Electrical Engg.)	Theraja B. L.,Theraja A. K.	S.Chand and Co. New Delhi, ISBN: 9788121924405
5.	Electrical and Electronic Measurement and Instrumentation	Rajput R.K.	S.Chand and Co. New Delhi, ISBN : 9789385676017

(b) Online Educational Resources:

1. https://www.digimat.in/nptel/courses/video/108105153/L01.html
2. https://freevideolectures.com/course/4111/nptel-electrical-measurement-electronic-instruments
3. https://asnm-iitkgp.vlabs.ac.in/List%20of%20experiments.html
4. https://www.fer.unizg.hr/en/course/foemai
5. https://www.circuitspecialists.com/blog/analog-or-digital-multimeter/
6. https://www.tutorialspoint.com/electronic_measuring_instruments/electronic_measuring_instruments_dc_bridges.html
7. https://www.elprocus.com/different-types-bridge-circuits-and-circuit-diagrams/
8. https://nptel.ac.in/courses/108105153

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. A Handbook on Measuring Instruments: The Blue Book (Part 1) Kindle Edition
2. Calibration Handbook of Measuring Instruments, 2017 edition
3. Instruments User Guide
4. Lab Manuals

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A) Course Code : 2421303(T2421303/P2421303/S2421303)

B) Course Title : Digital Electronics (ELX, ELX (R))

C) Pre- requisite Course(s) : Basic Engg. Mathematics, Basic Electronics Engg.

D) Rationale :

Currently, most of the state-of-art electronic equipment like mobiles, computers, ATM, TV, music system, air conditioners, automobiles are embedded with digital circuits, which the diploma electronic engineering pass outs have to test, troubleshoot and maintain. The IC used in electronic equipment needs continuous monitoring for their proper upkeep. For this work, knowledge and skills related with logic gates, combinational circuits, sequential circuits, and memory is a must.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Use number system and codes for interpreting the working of digital system.

CO-2 Minimize the Boolean expressions and implement it using logic gates.

CO-3 Test simple combinational circuits.

CO-4 Test simple sequential circuits.

CO-5 Use data converters and memory in digital electronic systems.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	1	-	-	-	1	1		
CO-2	3	-	-	-	-	1	1		
CO-3	-	-	3	-	-	1	1		
CO-4	-	-	3	-	-	1	-		
CO-5	3	-	-	-	-	1	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Teaching & Learning Scheme (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2421303	Digital Electronics	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2421303	Digital Electronics	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)
PLA:Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
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I) 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), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2421303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Convert the one number system into another. *TSO 1b.* Perform the specific arithmetic operation with respect to provided number in a given number systems. *TSO 1c.* Determine r's and (r-1)'s complement of different number systems. *TSO 1d.* Represent data in 1's and 2's complement. *TSO 1e.* Use 1's and 2's complement for subtraction. *TSO 1f.* Convert the given coded number into the other specified code.	**Unit-1.0 Number Systems and Codes** 1.1 Different number systems: • Binary, Octal, Decimal, Hexadecimal • Conversion from one number system to another number systems 1.2 Arithmetic operation: • Binary, Octal, Hexadecimal number 1.3 Complements: r's and (r-1)'s complement for all number systems 1.4 Data Representation: • Representation of negative number in 1's and 2's complement. • Subtraction using 1's and 2's complement 1.5 Codes: • Gray code, BCD codes, Excess-3 Codes, ASCII, and EBCDIC	**CO1**
TSO 2a. Simplify the given logical expression using Boolean laws. *TSO 2b.* Convert the given expression into standard (Canonical) SOP and POS form. *TSO 2c.* Minimize the given Boolean expression using K-map. *TSO 2d.* Realize the logic gates using universal gates. *TSO 2e.* Realize the logical expression using universal gates.	**Unit- 2.0 Boolean Algebra and Logic Gates** 2.1 Boolean Algebra: • Rules and laws of Boolean Algebra • Duality theorem • De-Morgan's Theorem • Simplification of logical expressions using Boolean laws. 2.2 Standard Boolean Representation: • Sum of Product (SOP) • Product of Sum (POS) 2.3 Minimization: • Karnaugh's Map (K-map) • Simplification of Boolean expressions using K-map. • Introduction of Tabulation method. 2.4 Logic Gates and applications: • AND, OR, NOT, Buffer, NAND, NOR, XOR, XNOR (Symbol, Truth table, Logic expression and its applications) 2.5 Implementation: • Implementation of Boolean expressions and logic functions using basic gates and universal gates. 2.5 TTL Logic Family	**CO1, CO2**
TSO 3a. Develop simple arithmetic circuits using universal gates. *TSO 3b.* Implement higher order multiplexer using lower order multiplexer. *TSO 3c.* Develop the logic circuit for code converter. *TSO 3d.* Develop the logic circuit for 1-bit comparator. *TSO 3e.* Develop the logic circuit for encoder and	**Unit-3.0 Combinational Logic Circuits** 3.1 Arithmetic Circuits: • Half and Full Adder • Half and Full Subtractor • Parallel and Series Adders 3.2 Multiplexer:	**CO2, CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
decoder. *TSO 3f.* Use IC 74151 to design multiplexer.	• 2 to 1 MUX • 4 to 1 MUX • 8 to 1 MUX • Applications • Introduction to design of Multiplexer using K-map and tabulation method 3.3 De-multiplexer: • 1 to 2 DEMUX • 1 to 4 DEMUX • 1 to 8 DEMUX • Applications 3.4 Code Converter: • Binary to BCD • BCD to Excess-3 • BCD to gray code 3.5 Comparator: 1-bit comparator 3.6 Encoder: Octal, Hexadecimal and BCD to Binary 3.7 Decoder: Binary to Octal, Hexadecimal and BCD	
TSO 4a. Differentiate combinational and sequential circuit. *TSO 4b.* Differentiate Latch and Flip-Flop. *TSO 4c.* Use the given flip-flop to construct the specific type of counter. *TSO 4d.* Design the specified Modulo-N counter. *TSO 4e.* Construct the synchronous counter for random sequence.	**Unit-4.0 Sequential Logic Circuits** **4.**1 Basic Memory Cell: SR latch using NAND/NOR 4.2 Triggering Method: Edge trigger and level trigger 4.3 Flip-Flops : • SR, JK, T, D, and JK-Master Slave 4.4 Counters: • Modulus of counter • Asynchronous Counter: Ripple up/down counter and Decade Counter • Synchronous Counter: Ring Counter and Johnson Counter. 4.5 Shift Registers: • Serial in Serial Out • Serial in Parallel Out • Parallel in Serial Out • Parallel in Parallel Out • Universal	**CO2, CO3, CO4**
TSO 5a. Calculate the output voltage of the R-2R ladder for the given specified digital input. *TSO 5b.* Calculate the output voltage of the weighted resistor DAC for the given specified digital input. *TSO 5c.* Explain with sketches the working principle of the given type of ADC. *TSO 5d.* Explain the working principle of the given type of memory. *TSO 5e.* Compare various type of memory	**Unit-5.0 Data Converters & Memory Devices** 5.1 Data Converters: • DAC- Weighted resistor type and R-2R ladder type • ADC- Ramp type, SAR type, Flash Type, Dual Slope type 5.2 Random Access Memory: • Organization • Address Lines • Memory Size • Static RAM • Bipolar RAM • Cell Dynamic RAM • DRAM • DDR RAM 5.3 Read Only Memory: • Organization	**CO4, CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	• Expanding memory • PROM • EPROM • EEPROM • Flash memory	

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2421303

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 List the IC number of all logic gates. *LSO 1.2* Verify the truth table of given logic gate.	1.	Functionality of OR, AND & NOT logic gates using ICs	CO2
LSO 2.1 Build the circuit on breadboard for making AND gate using NAND gate. *LSO 2.2* Verify the truth table of the developed AND gate. *LSO 2.3* Build the circuit on breadboard similarly for other gates using NAND gate. *LSO 2.4* Verify the truth table of the developed gates.	2.	Logic gates using universal NAND gate IC	CO2
LSO 3.1 Build the circuit on breadboard for making AND gate using NOR gate. *LSO 3.2* Verify the truth table of the developed AND gate. *LSO 3.3* Build the circuit on breadboard similarly for other gates using NOR gate. *LSO 3.4* Verify the truth table of the developed gate.	3.	Logic gates using universal NOR gate IC	CO2
LSO 4.1 Build the circuit of Half adder using basic gates on breadboard. *LSO 4.2* Test the functionality of Half Adder.	4.	Half adder using basic gates	CO2, CO3
LSO 5.1 Build the circuit of Half Subtractor using basic gates on breadboard. *LSO 5.2* Test the functionality of Half Subtractor.	5.	Half subtractor using basic gates	CO2, CO3
LSO 6.1 Build the circuit of Full Adder using NAND gate on breadboard. *LSO 6.2* Check the result of binary addition on the developed circuit.	6.	Full Adder using NAND gates	CO2, CO3
LSO 7.1 Build the circuit of Full Subtractor using NOR gate on breadboard. *LSO 7.2* Check the result of binary subtraction on the developed circuit.	7.	Full Subtractor using NOR gates	CO2, CO3
LSO 8.1 Build the circuit connection of multiplexer on trainer kit. *LSO 8.2* Test whether the particular input line is available at output for given data select line.	8.	Functionality of multiplexer	CO3
LSO 9.1 Build the circuit connection of multiplexer on breadboard. *LSO 9.2* Test whether the particular input line is available at output for given data select line.	9.	Multiplexer design using ICs (74151/74150)	CO2, CO3
LSO 10.1 Build the circuit connection of De-multiplexer on trainer kit. *LSO 10.2* Test whether the given data available at input is distributed correctly to output for given data select line.	10.	Functionality of de-multiplexer	CO3

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 11.1 Build the circuit connection of De-multiplexer on breadboard. *LSO 11.2* Test whether the given data available at input is distributed correctly to output for given data select line or not.	11.	De-multiplexer design using ICs (74154/74155)	CO2, CO3
LSO 12.1 Build the circuit of SR flip-flop using NAND gates on breadboard. *LSO 12.2* Verify the characteristic table of SR flip-flop.	12.	SR flip-flop using NAND gates	CO2, CO4
LSO 13.1 Build the circuit of SR flip-flop on trainer kit. *LSO 13.2* Verify the characteristic table of SR flip-flop.	13.	SR flip-flop using NOR gates	CO2, CO4
LSO 14.1 Construct the circuit of MS-JK flip flop on breadboard. *LSO 14.2* Verify the characteristic table of MS-JK flip flop.	14.	MS-JK flip-flop using IC 7476	CO4
LSO 15.1 Build the circuit of D flip-flop on breadboard. *LSO 15.2* Test the functionality of D flip-flop.	15.	D flip-flop using IC 7476	CO4
LSO 16.1 Build the circuit of T flip-flop on breadboard. *LSO 16.2* Test the functionality of T flip-flop.	16.	T flip-flop using IC 7476	CO4
LSO 17.1 Build the circuit of 4-bit shift register using flip-flop on breadboard. *LSO 17.2* Test the functionality of 4-bit shift register.	17.	4-bit shift register using flip-flop	CO4
LSO 18.1 Simulate the circuit of 4-bit shift register using EDA/ simulation tool. *LSO 18.2* Test the functionality of 4-bit shift register	18.	4-bit shift register using flip-flop simulation	CO4
LSO 19.1 Build the circuit of Decade counter on breadboard. *LSO 19.2* Test the functionality of Decade counter.	19.	Decade Counter (0-9) using IC 7490	CO1, CO4
LSO 20.1 Construct the circuit of Decade counter using EDA/ simulation tool. *LSO 20.2* Simulate the circuit of Decade counter using EDA/ simulation tool. *LSO 20.3* Test the functionality of Decade counter.	20.	Decade Counter Simulation	CO1, CO4
LSO 21.1 Build the circuit of digital to analog converter on breadboard. *LSO 21.2* Test the functionality of digital to analog converter.	21.	R-2R resistive network for digital to analog conversion	CO5
LSO 22.1 Construct the circuit of digital to analog converter using EDA/ simulation tool. *LSO 22.2* Simulate the circuit of D to A converter. *LSO 22.3* Test the functionality of digital to analog converter.	22.	R-2R resistive network simulation for digital to analog conversion	CO5

L) Suggested Term Work and Self Learning: S2421303 Some sample suggested assignments, micro project and otheractivities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs. Some sample assignments are given below:

- Draw logic circuit of Boolean function F = AB + $\overline{A}$C + B$\overline{C}$ using AND, OR and NOT gates only.
- Define Boolean algebra with its law.

- Minimize the Boolean Function F(W,X, Y,Z) = ∑ (0,1,4,5,8,9,13,15) using K-map method.
- Implement all logic Gates using NOR Gate.
- Draw logic circuit of Boolean function F = AB + $\bar{A}$C + B$\bar{C}$ using AND, OR and NOT gates only.
- Draw logic diagram of Full subtractor and write its truth table.
- Explain the Encoder with suitable circuit diagram.
- Write any four differences between Synchronous and Asynchronous counter.
- Explain SR flip-flop with the help of logic diagram and write its truth table.
- Write the excitation table and characteristic equation of T Flip-Flop.

b. Micro Projects:

1. Build a Binary to Gray code converter trainer kit.
2. Build a circuit to implement 4-bit adder.
3. Build a circuit for LED flasher.
4. Build a trainer kit of 4 to 1 multiplexer.
5. Build a circuit to test seven segment display.
6. Build a circuit to display the pin code of your college using seven segment display.
7. Undertake a market survey of digital IC's required for different applications.

c. Other Activities:

1. Seminar Topics:

- Biometric voting machine
- Night vision technology
- Digital locker
- Barcodes Reader

2. Visits: Visit nearby radio station/industry/ electronic shops. Prepare report of visit with special comments of digital electronics component/batch production/mass production and cost of component.

3. Self- learning topics:

- PCB design technique
- Key board encoder
- 2-bit comparator
- Carry look ahead adder
- Self-complimentary code like 2421, 3321

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	15%	15%	-	20%	0%	10%
CO-2	15%	20%	20%	25%	20%	0%	20%
CO-3	30%	25%	25%	25%	20%	15%	20%
CO-4	30%	25%	20%	25%	20%	15%	20%
CO-5	15%	15%	20%	25%	20%	10%	10%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

* : Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

** : Mentioned under point- (N)

: Mentioned under point-(O) **Note:**

- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction (CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Number Systems and Codes	8	CO1	12	4	4	4
Unit-2.0 Boolean Algebra and Logic Gate Applications	10	CO1, CO2	15	4	5	6
Unit-3.0 Combinational Logic Circuits	10	CO2, CO3	15	4	5	6
Unit-4.0 Sequential Logic Circuits	11	CO2, CO3, CO4	16	4	6	6
Unit-5.0 Data Converters and Memory Devices	9	CO4, CO5	12	4	4	4
Total	**48**	**-**	**70**	**20**	**25**	**25**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Functionality of OR, AND & NOT logic gates using ICs	CO2	30	60	10
2.	Logic gates using universal NAND gate IC	CO2	40	50	10
3.	Logic gates using universal NOR gate IC	CO2	40	50	10
4.	Half adder using basic gates	CO2, CO3	30	60	10
5.	Half subtractor using basic gates	CO2, CO3	30	60	10
6.	Full Adder using NAND gates	CO2, CO3	40	50	10
7.	Full Subtractor using NOR gates	CO2, CO3	40	50	10
8.	Functionality of multiplexer	CO3	20	70	10
9.	Multiplexer design using ICs (74151/74150)	CO2, CO3	40	50	10
10.	Functionality of de-multiplexer	CO3	20	70	10
11.	De-multiplexer design using ICs (74154/74155)	CO2, CO3	40	50	10
12.	SR flip-flop using NAND gates	CO2, CO4	40	50	10
13.	SR flip-flop using NOR gates	CO2, CO4	40	50	10
14.	MS-JK flip-flop using IC 7476	CO4	30	60	10
15.	D flip-flop using IC 7476	CO4	30	60	10
16.	T flip-flop using IC 7476	CO4	30	60	10
17.	4-bit shift register using flip-flop	CO4	40	50	10
18.	4-bit shift register using flip-flop simulation	CO4	40	50	10
19.	Decade Counter (0-9) using IC 7490	C01, CO4	40	50	10
20.	Decade Counter Simulation	C01, CO4	40	50	10
21.	R-2R resistive network for digital to analog conversion	C05	40	50	10
22.	R-2R resistive network simulation for digital to analog conversion	C05	40	50	10

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

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to beprepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools, and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Oscilloscope	Dual Channel 20MHz	All
2.	Function generator	100MHz Function & Arbitrary Generator, 500MSa/s-DG4102	All
3.	Digital IC Trainer Kits	Power Supply: +5V, +/- 12V Display Type: 2 Digit BCD to Decimal Display	All
4.	Logic Gates ICs	Two input and 3-Input	All
5.	Bread Board	MB 102 Breadboard with Power Supply Module, Jumper Wires, Battery Clip,830 & 400 tie-Points	All
6.	Digital Multimeter	DM-86 Digital Multimeter AC Frequency Response: 40-400Hz Low Battery Display: Approx. < 7.5V	All
7.	IC Tester	• Package: Digital ICs of 14, 16, 18,20,24,28 & 40 pins dual in line. • Range: Tristate, Open Collector & Bidirectional TTL/CMOS ICs. • Method: Truth table comparison. • Sockets: 20 and 40 pin ZIF. • Keyboard: 24 feather touch keys. • Display: 16 digit 0.5" Seven segment LED display. • Voltage: 230 volts + 10% 50Hz, AC.	All

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Digital principles & Applications	Albert Paul Malvino & Donald P. Leach	McGraw Hill Education; Eighth edition ISBN: 978-9339203405
2.	Digital Electronics, Principles and Applications	Roger L. Tokheim	McGraw-Hill Education (ISE Editions); International 2 Revised edition ISBN: 978-0071167963
3.	Digital Electronics – An Introduction to Theory and Practice	William H. Gothmann	Prentice Hall India Learning Private Limited; 2 edition ISBN: 978-8120303485

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
4.	Fundamentals of Logic Design	Charles H. Roth, Larry L. Kinney	Jaco Publishing House; First edition ISBN: 978- 8172247744
5.	Digital Electronics	R. Anand	Khanna Publications, New Delhi (Edition 2018) ISBN: 978-9382609445

(b) Online Educational Resources:

1. https://nptel.ac.in/courses/108105132
2. https://onlinecourses.nptel.ac.in/noc22_ee55/preview
3. https://archive.nptel.ac.in/courses/108/105/108105132/
4. https://in.coursera.org/learn/digital-systems
5. Virtual Labs: https://www.vlab.co.in/
6. https://www.iitg.ac.in/cseweb/vlab/Digital-System-Lab/experiments.php

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educationalrecourses before use by the students.

(c) Others:

1. Operating / Manufacturers' Manuals
2. Lab Manuals
3. Data books / Data sheets of digital components (TTL, CMOS, etc.)
4. Softwares like NI Circuit Design Suite/ Xcircuit / easyEDA/ circuitlab & like.

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A) Course Code : **2421304(T2421304/P2421304/S2421304)**

B) Course Title : Principles of Electronic Communication

C) Pre-requisite Course(s) : Applied Engineering Mathematics

D) Rationale :

Modern Society and Industry both are fully dependent on telecommunication systems, not only for communications but for all the other services provided by the communication networks like rail and air reservations, e-commerce, remote data sensing and access, telemedicine, internment, etc. This course is designed to provide knowledge of basic operating principles and handling of various electronic communication systems and will also help the students to troubleshoot and maintain electronic systems used in various types of telecommunication industries. This course will also help in developing the concepts of electronic communication which will be further used to take up the advanced courses in the upper semesters.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of the following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor, and Affective) in the classroom/laboratory/workshop/field/industry.

After completion of the course, the students will be able to-

CO-1 Use relevant frequency range for different types of communication systems.
CO-2 Use various types of signals for testing communication systems.
CO-3 Analyze the effect of different types of noise on the communication system.
CO-4 Analyze Analog Modulated and Demodulated Signal.
CO-5 Maintain simple communication transmitters and receivers.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/development of solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and environment	**PO-6** Project Management	**PO-7** Life-long learning	**PSO-1**	**PSO-2**
CO-1	2	1	1	2	1	2	1		
CO-2	2	2	1	2	1	2	1		
CO-3	2	3	2	2	1	2	1		
CO-4	2	3	2	2	1	2	1		
CO-5	2	3	3	2	1	2	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2421304	Principles of Electronic Communication	03	-	04	02	09	06

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2421304	Principles of Electronic Communication	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in the classroom (includes class test, mid-term test, and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work &Self Learning Assessment (includes assessment related to student performance in assignments, seminars, micro-projects, industrial visits, self-learning, any other student activities, etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignments, micro-projects, seminars, and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria for internal as well as external assessment may vary as per the requirement of the respective course. For valid and reliable assessment, the internal faculty should prepare a checklist & rubrics for these activities.

I) 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), Term Work (TW), and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to the attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020-related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS), and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: T2421304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Classify frequency bands used for various communication systems. TSO 1b. Sketch the labeled diagram of the electromagnetic (EM) wave spectrum used for electronic communication and suggest the applications of each band. TSO 1c. Classify various communication channels with examples. TSO 1d. Suggest the frequency band for the given type of communication. TSO 1e. Differentiate between analog and digital communication.	**Unit-1.0 Introduction to Communication System** 1.1 Basic building blocks of communication system: Transmitter, receiver, channel, antenna, multiplexer, encoder, decoder 1.2 Electromagnetic spectrum, different frequency bands, and their applications, Concept of bandwidth 1.3 Modes of communication: Simplex, Half duplex, and full duplex 1.4 Examples of wired and wireless channels (basic idea only):- telephone channel, coaxial cable, optical fiber cable, wireless broadcast channel 1.5 Difference between Analog and Digital communication	CO1
TSO 2a. Sketch the labeled waveform of the given type of signal. TSO 2b. Classify the signals with examples. TSO 2c. Differentiate the characteristics of the given type of signals. TSO 2d. Calculate the periodicity of the given signal. TSO 2e. Perform the given operation on the given type of signal. TSO 2f. Analyze the given signal with the help of the Fourier series / Fourier Transform.	**Unit-2.0 Introduction to Signals** 2.1 Represent test signals like pulse, sine, cosine, gate pulses, sawtooth, triangular, and other periodic and non-periodic signals 2.2 Classification of Signals: Continuous and Discrete signals, Deterministic and Random signals, Periodic and non-Periodic signals, Energy and Power signals, causal and non-causal signals, and Even and Odd signals (For both Continuous and Discrete signals) 2.3 Basic Operations on Signals: Time shifting, Time scaling, Time reversal 2.4 Fourier series and Fourier transform to analyze the basic signals	CO2
TSO 3a. Identify different sources of noise present in the communication system. TSO 3b. Classify different types of noise.	**Unit-3.0 Noise** 3.1 Introduction: - Noise, sources of noise, difference between noise and error	CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3c. Explain noise parameters with justification. TSO 3d. Analyze the effect of white noise on the given communication system. TSO 3e. Define the figure of merit of the given type of communication system.	3.2 Classification of noise: - shot noise, partition noise, Flicker noise, High-frequency noise, Thermal Noise, Additive White Gaussian noise 3.3 Relation between noise power and bandwidth, Noise bandwidth, signal-to-noise ratio, Figure of merit, Noise factor, Noise figure, Noise temperature, and equivalent noise temperature of amplifiers connected in cascade	
TSO 4a. Explain the need for modulation. TSO 4b. Calculate the bandwidth, power, and modulation index for a given AM signal. TSO 4c. Analyze carrier power and sideband power of the AM waveform. TSO 4d. Calculate the bandwidth, power, frequency deviation ratio, and modulation index of a given FM signal. TSO4e. Compare the performance of AM and FM.	**Unit-4.0 Analog Modulation** 4.1 Concept and need for modulation 4.2 Amplitude modulation: Simple mathematical representation of AM, DSB, SSB, efficiency and percentage of modulation, bandwidth, and power the requirement in AM, DSB, SSB generation and detection of AM (Basic idea only) 4.3 Angle Modulation: Representation of FM signal and PM signal, Bandwidth and Power requirement in FM & PM, Principles of operation of frequency modulation using varactor diode and Voltage controlled oscillator (VCO)	**CO4**
TSO 5a. Explain with sketches the working of the given type of AM generation technique. TSO 5b. Explain with sketches the given type of AM demodulation technique. TSO 5c. Describe the various characteristics and parameters (selectivity, sensitivity, and fidelity) of the radio receiver. TSO 5d. Explain with sketches the principle of the given type of FM generation technique. TSO 5e. Describe the working of PLL using a neat block diagram. TSO 5f. Define Capture and Lock Range of a PLL. TSO 5g. Explain the functions of the given blocks of the Tuned Radio Frequency Receiver and Super Heterodyne Receiver. TSO 5h. Explain the concept of Image Frequency and the procedure to suppress Image Frequency. TSO 5i. Differentiate the working principle of Pre-emphasis and De-emphasis circuits used in FM systems. TSO 5j. Compare the working of the given type of	**Unit-5.0 Transmitters and Receivers** 5.1 Block diagram and functions of different blocks of AM and FM Transmitter 5.2 Block diagram and function of different blocks of AM and FM Receiver 5.3 Transmitter and receiver antenna, antenna parameters, and specifications 5.4 Tuned Radio frequency (TRF) receiver, Super heterodyne Analog AM/FM receivers: Block diagram and the principle of operation of a superheterodyne receiver 5.5 Receiver Characteristics &Testing – sensitivity, selectivity, and fidelity, Pre-emphasis, and de-emphasis circuits 5.6 Generation of FM using the Direct method (Voltage Controlled Oscillator) and Indirect method (Armstrong Method) 5.7 Demodulation of FM using Phase Locked Loop (PLL)	**CO5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
FM detector.		

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2421304

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number (s)
LSO 1.1 Interpretation and functions of various sections of a communication system.	1	Identify the different components/sections of the given communication system	CO1
LSO 2.1 Use a function generator to generate different waveforms. *LSO 2.2* Use dual trace CRO to measure the amplitude and time/frequency of the displayed waveform.	2	Analyze various continuous time and discrete time signals	CO2
LSO 3.1 Test FM pre- emphasis and De-emphasis.	3	Test the frequency response of Pre-emphasis & De-emphasis circuits used in FM receiver	CO3
LSO 4.1 Measure the SNR of FM and AM systems.	4	Measure the noise parameter of the given communication system	CO3
LSO 5.1 Use MATLAB/Simulink communication toolbox to analyze noise performance of the cascaded system.	5	Calculate the Noise figure of the Amplifiers connected in cascade using simulation software	CO3
LSO 6.1 Use mathematical relations to find the modulation index.	6	Measure/Calculate the following for the given AM waveform 1. Carrier frequency 2. Modulating Frequency 3. Sampling frequency 4. Upper and lower side bandwidth Modulation index of amplitude modulated waveform	CO4
LSO 7.1 Use MATLAB/Simulink communication toolbox to generate amplitude modulated wave.	7	Sketch amplitude modulated wave using simulation software	CO4
LSO 8.1 Use MATLAB/Simulink communication toolbox to analyze frequency modulated wave.	8	Construct the frequency- modulated waveform and Calculate the modulation index using simulation software	CO4
LSO 9.1 Use IC 566 to generate FM waveform.	9	Generate frequency modulated waveform using digital IC and analyze it.	CO5
LSO 10.1 Use IC 565 to receive FM signal.	10	Generate frequency demodulated waveform using digital IC and analyze it	CO5
LSO 11.1 Measure the test paraments of AM receiver.	11	Test the performance of AM receiver	CO5
LSO 12.1 Measure the characteristics and parameters of AM receiver.	12	Measure the selectivity, sensitivity, and fidelity of the given Superheterodyne AM receiver	CO5

L) Suggested Term Work and Self Learning: S2421304 Some sample suggested assignments, micro projects, and otheractivities are mentioned here for reference.

a. Assignments:

1. Generate various signals using Simulation software and take the printout of the output waveform.
2. Perform basic operations on signals using simulation software and take the printout of the Input and output waveform.
3. Sketch an equivalent circuit for thermal noise and explain it.
4. Write short notes on the noise produced by internal sources of a communication system.
5. Prepare a chart of the electromagnetic spectrum used for the various electronic communication system.
6. List the advantages and disadvantages of an analog communication system.
7. Sketch the waveform of AM signal for the given modulation index.
8. Sketch the waveform of AM, FM, and PM signals and analyze it.

b. Micro Projects:

1. Build a circuit to generate AM waveform using IC MC1496/8038 on general purpose PCB and prepare the report.
2. Build a circuit to generate an FM waveform using general purpose PCB using IC 8038/ transistor BF549 and prepare a report.
3. Prepare circuit to demonstrate the simplex and duplex communication mode.
4. Build a circuit on general purpose PCB for tuning IFT at 455 KHz.
5. Prepare a report on the natural and manmade noise affecting the radio communication system.
6. Build and test a FM receiver circuit for local FM reception.
7. Build and test an AM receiver circuit for local AM reception.

c. Other Activities:

1. Suggested Seminar Topics:

- Prepare PPT on different types of internal and external types of noise.
- Commercially available ICs for analog communication.
- Prepare a chart to demonstrate the basic block diagram of transmitter and receiver and explain the concept of heterodyne principle.
- Types of Analog Transmission
- Analog-Digital Hybrid Modulation

2. **Visits:** Visit a nearby radio station/ Doordarshan Kendra. Prepare a report of the visit with special comments on types of the transmitter, receivers used and various frequency bands used.

3. Self-Learning Topics:

- Types of communication channels and their characteristics.
- Noise and its types.
- Sampling and Quantization process.
- Multiplexing and demultiplexing of channels
- Advantages and disadvantages of FM over AM
- Requirement of pre-emphasis and de-emphasis circuits in FM transmitter and receiver.
- Importance of VSB transmission in Television Broadcasting.
- Importance of white Gaussian noise in a communication system.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use the appropriate assessment strategy and its weightage in theory, laboratory, and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	10%	15%	-	-	20%	20%
CO-2	10%	20%	10%	25%	-	10%	20%
CO-3	15%	20%	15%	25%	33%	15%	20%
CO-4	30%	20%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*** :** Other Activities include self-learning, seminar, visits, surveys, product development, software development, etc.

****:** Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- In the case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided among all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises questions related to the achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: The specification table represents the reflection of sample representation of assessment of the cognitive domain of the full course.

Unit Title and Number	Total Classroom Instruction (Cl) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Communication System	6	CO1	7	2	2	3
Unit-2.0 Introduction to Signals	10	CO2	14	4	4	6
Unit-3.0 Noise	10	CO3	14	4	4	6
Unit-4.0 Analog Modulation	10	CO4	14	4	4	6
Unit-5.0 Transmitters and Receivers	12	CO5	21	6	7	8
Total Marks	**48**		**70**	**20**	**21**	**29**

Note: Similar table can also be used to design class/ mid-term/ internal question papers for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number (s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Identify the different components/sections of the given communication system.	CO1	40	50	10
2.	Analyze various continuous time and discrete time signals.	CO2	40	50	10
3.	Test the frequency response of Pre-emphasis & De-emphasis circuits used in FM receiver.	CO3	40	50	10
4.	Measure noise parameter of the given communication system.	CO3	40	50	10
5.	Calculate noise figure of the Amplifiers connected in cascade using simulation software.	CO3	40	50	10
6.	Measure/Calculate the following for the given AM waveform 1. Carrier frequency 2. Modulating Frequency 3. Sampling frequency 4. Upper and lower side bandwidth Modulation index of amplitude modulated waveform	CO4	40	50	10
7.	Sketch amplitude modulated wave using simulation software.	CO4	40	50	10
8.	Construct the frequency-modulated waveform and calculate the modulation index using simulation software.	CO4	40	50	10
9.	Generate frequency-modulated waveform using digital IC and analyze it.	CO5	40	50	10
10.	Generate frequency demodulated waveform using digital IC and analyze it.	CO5	40	50	10
11.	Test the performance of AM receiver.	CO5	40	50	10
12.	Measure the selectivity, sensitivity, and fidelity of the given Super heterodyne AM receiver.	CO5	40	50	10

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

Note: This table can be used for both end semester as well as progressive assessment of practicals. Rubrics need to be prepared by the course teacher for each experiment/ practical to assess the student's performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lectures, Tutorial, Case Methods, Group Discussions, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Labs, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs, etc.

Q) List of Major Laboratory Equipment, Tools and Software:

Sl. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number (s)
1.	Cathode Ray Oscilloscope	Dual Trace 50 MHz, Input impedance -1Mega ohm, with component tester and function generator	All
2.	Digital Storage Oscilloscope	Signal BW: 50/100MHz, TFT color LCD, Dual channel, Real time sampling: 1GSa/s, Equivalent sampling: 25GSa/s, Memory 1M pts, 10 waveforms and 10 setups can be stored	All
3.	RF signal generator	Wide frequency range 100KHz to 150MHz fine frequency adjustment by calibrated dial built-in audio frequency generator	1,2,5
4.	Regulated Power Supply	DC supply voltage dual DC: 2 X 0-30V,0-2 A automatic overload (current protection), constant voltage and constant current operation	All
5.	Amplitude Modulation Demodulation Trainer Kit	DSB/SSB AM modulation and demodulation. On board carrier generator 100KHz, on board modulating signal oscillator 0-1KHz, fixed DC power supplies 15V DC, 250mA, operated on mains power 230V, 50Hz	2,3,8
6.	FM Trainer Kit	FM modulation and demodulation. On board carrier signal, FM Modulation using XR 2206 IC, 4^{th} Order LPF, Internal Power Supply +5V, +12V/500mA, user friendly front panel block diagram	5,6,9,10
7.	Digital Multimeter	3 ½ digital display, 9999 count digital multimeter measures: V_{ac}, V_{dc} (1000V max), A_{dc} ,A_{ac} (10Amp max), Resistance (0-100M ohm), Capacitance and Temperature measurement	3,6
8.	Trainer kit for FM modulator using IC 566	AC source: 600Hz to 2.5KHz, FM Modulator: VCO test points, circuit diagram engraved on front panel with transparent rear panel	9
9.	Trainer kit for FM demodulator using IC 565	AC source: 600Hz to 2.5KHz, FM Demodulator: PLL test points	10
10	Simulation Software	SCILAB, MATLAB, TINA PRO etc. Suitable for performing Analog Communication experiments	4,7,12

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Electronic Communication Systems	Kennedy George, Davis Bernard, Prasanna SRM	McGraw Hill, 5^{th} edition, 2011 ISBN-13: 978-0071077828
2.	Modern Digital and Analog Communication Systems	B. P. Lathi, Zhi Ding	Oxford University Press, 2010, 4^{th} edition ISBN- 13: 978-0198065340
3.	Communication Systems	Simon Haykin, Michael Moher	Wiley, 2009, 5^{th} edition ISBN-13: 978-8126521517
4.	Principles of Electronics Communication	Mrs. Pratibha Kulkarni Ms. Sharvari Kulkarni	Nirali Prakashan, 2019 ISBN-13: 978-9387686748

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
5.	Electronic Communication	Dr. Vimal Bhatia	AICTE, January 2023 ISBN- 978-81-959863-4-7

(b) Online Educational Resources:

1. https://onlinecourses.nptel.ac.in/noc21_ee74/preview
2. https://archive.nptel.ac.in/courses/112/104/112104265/
3. https://www.youtube.com/watch?v=F3slBe2r8vA&list=PLq-Gm0yRYwTgX2FkPVcY6io003-tZd8Ru
4. https://archive.nptel.ac.in/content/syllabus_pdf/117105143.pdf
5. https://www.academia.edu/9701843/analog_communication

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Analog Communication Users' Guide
2. Analog Communication Techniques Engineering Handbook
3. Lab Manuals

*****

A) Course Code : **2421305(P2421305/S2421305)**

B) Course Title **:** Electronic Simulation Software Practice (ELX, ELX (R))

C) Pre- requisite Course(s) **:** Basic Electronics

D) Rationale **:**

Simulation software is used widely to design equipment so that the final product will be as close as possible to design specifications without expensive in process modification. Electronics simulation software utilizes models to replicate the behavior of an actual electronic device or circuit. Essentially, it is a software program that converts one's computer into a fully functioning electronics laboratory. Simulation provides verification of the basic theory, understanding the basic principles, greater attention to the theoretical limitations, and application of logical analysis to solve real-world problems. This course discusses simulation software packages used in electronics for better understanding with special emphasis on EDA/simulation tool for analog and digital circuits. After creating an electronic circuit, it is necessary to test the circuit in order to confirm its functionality and make any necessary adjustments.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Use schematic editor by selecting appropriate EDA/simulation tools.

CO-2 Analyze analog circuits using appropriate EDA/simulation tools. **CO-3** Analyze digital circuits using appropriate EDA/simulation tools.

CO-4 Use EDA/simulation tools to analyze various DC and AC circuits. **CO-5** Apply PCB design skills to create PCB layout of electronic circuits.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	2	2	2	-	2		
CO-2	3	3	2	2	-	-	-		
CO-3	3	3	2	2	-	-	-		
CO-4	3	2	2	2	-	-	-		
CO-5	3	-	2	3	3	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional.

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2421305	Electronic Simulation Software Practice	-	-	04	02	06	03

Legend:

CI: Classroom Instruction (Includesdifferentinstructional/implementationstrategiesi.e.Lecture (L), Tutorial (T), Case-method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits= (1xCI hours) + (0.5xLI hours) + (0.5xNotional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2421305	Electronic Simulation Software Practice	-	-	20	30	20	30	100

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro-projects, industrial visits, self-learning, any other student activities, etc.)

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, and seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) 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), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: This is a lab-oriented course and there is no theory assessment. However, it is expected that through the lab work and discussions, there will be efforts to achieve the outcomes mentioned below.

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe the installation procedure of the given EDA/simulation tool. *TSO 1b.* List main features of the given EDA tool. *TSO 1c.* Explain use of different windows to perform various operations of the given EDA tool. *TSO 1d.* Explain procedure to perform the given file operation. *TSO 1e.* Describe procedure to perform the given operation on schematic design windows of EDA tool. *TSO 1f.* Use EDA/simulation tool to create new file.	**Unit-1.0 Introduction to EDA/Simulation Tool** 1.1 Installation of appropriate EDA/simulation tool 1.2 Main features of EDA tools 1.3 Different editing windows 1.4 Draw the schematic diagram of circuits using proper connection 1.5 Procedure of file handling	**CO1**
TSO 2a. Construct the clipper and clamper circuits. *TSO 2b.* Construct the half wave and full wave rectifier circuits. *TSO 2c.* Compare different configuration of BJT as an amplifier using simulation results. *TSO 2d.* Construct different types of passive filters. *TSO 2e.* Compare the characteristics of thyristor devices like SCR, DIAC, and TRIAC using simulation result.	**Unit-2.0 Analog Circuits Simulation** 2.1 Clipper & Clamper circuits 2.2 Rectifiers: • Half-wave Rectifiers • Centre Tapped full wave Rectifier • Full wave Bridge Rectifier 2.3 BJT Amplifiers: • CE Amplifier • CB Amplifier • CC Amplifier 2.4 Passive Filters: • Low Pass Filter • High Pass Filter • Band stop Filter • Band pass Filter 2.5 SCR, DIAC, TRIAC	**CO2, CO1**
TSO 3a. Construct the circuit diagram of half adder/subtractor using basic gates. *TSO 3b.* Construct the circuit diagram of full adder/subtractor using universal gates. *TSO 3c.* Construct circuit diagram of Full adder/sub tractor using half adder/subtractor. *TSO 3d.* Construct the circuit diagram of multiplexer/demultiplexer. *TSO 3e.* Construct the circuit diagram of different types of flip-flops.	**Unit-3.0 Digital Circuits Simulation** 3.1 Logic Gates 3.2 Half Adder/Subtractor 3.3 Full Adder/Subtractor 3.4 Multiplexer and Demultiplexer 3.5 Flipflops • R-S Flip Flop • J-K Flip Flop • D and T Flip flop 3.6 ADC, DAC 3.7 Data acquisition system	**CO3, CO1**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3f. Describe working of ADC and DAC. *TSO 3g.* Identify the different blocks of Data acquisition system.		
TSO 4a. Calculate current and voltage using nodal and mesh analysis in a given circuit. *TSO 4b.* Use Thevenin's Theorem to calculate V_{th}, R_{th} and load current in the given circuit. *TSO 4c.* Use Norton's Theorem to calculate I_N, R_N and load current in the given circuit. *TSO 4d.* Use Superposition Theorem to calculate the current in any branch of the circuit. *TSO 4e.* Construct the circuit diagram of series R-L, R-C, R-L-C circuits.	**Unit-4.0 Electrical Circuits Simulation** 4.1 Concepts of Mesh and Nodal analysis 4.2 Fundamentals of Network Theorems • Thevenin's Theorem • Norton's Theorem • Superposition Theorem 4.3 Basics of Series AC Circuits • R-L Circuit • R-C Circuit • R-L-C Circuit	**CO4, CO1**
TSO 5a. Explain the basics of PCB design. *TSO 5b.* Describe different interfaces of PCB design software including tools and menus. *TSO 5c.* Explain process of creating schematic of electronic circuit using symbol and components. *TSO 5d.* Explain process of generation of PCB file formats of PCB layout.	**Unit-5.0 PCB Design using Simulation Tool** 5.1 Introduction to PCB Design 5.2 PCB design Software: Interface and Tools 5.3 Schematic Capture: Symbols and Components for creating circuit 5.4 PCB Layout 5.5 PCB file formats	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical : P2421305

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Install EDA software. *LSO 1.2.* Practice different Interfaces of EDA tools.	1.	Installation and operation of the given EDA tool.	CO1
LSO2.1 Simulate the clipper circuits. *LSO2.2* Analyze the output waveform for clipper circuit.	2.	Test the functionalities of positive clipper circuits & negative clipper circuits using appropriate EDA/simulation tool.	CO2, CO1
LSO 3.1. Simulate the clamper circuits. *LSO 3.2.* Analyze the output waveform for clamper circuit.	3.	Test the functionalities of clamper circuits using appropriate EDA/simulation tool.	CO2, CO1
LSO 4.1. Simulate the half wave rectifier circuit. *LSO 4.2.* Analyze the output waveform for half wave rectifier circuit.	4.	Test the functionalities of half wave rectifier circuit using appropriate EDA/simulation tool.	CO2, CO1
LSO 5.1. Simulate the schematic diagram of center tapped full wave rectifier circuit. *LSO 5.2.* Analyze the output waveform for center tapped full wave rectifier circuit.	5.	Test the functionalities of center tapped full wave rectifier circuit using appropriate EDA & simulation tool.	CO2, CO1
LSO 6.1. Simulate the schematic diagram of bridge full wave rectifier circuit. *LSO 6.2.* Analyze the output waveform for bridge full wave rectifier circuit.	6.	Test the functionalities of bridge full wave rectifier circuit using appropriate EDA/simulation tool.	CO2, CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 7.1. Simulate the filter circuit on EDA tool. *LSO 7.2.* Analyze the output waveform for various passive filter circuits.	7.	Test the functionalities of passive filter circuits using appropriate EDA/simulation tool.	CO2, CO1
LSO 8.1. Simulate the circuit of SCR using EDA tool. *LSO 8.2.* Analyze the output waveform of SCR.	8.	Test the VI characteristics of SCR.	CO2, CO1
LSO 9.1. Simulate the circuit of DIAC using EDA tool. *LSO 9.2.* Analyze the output waveform of DIAC.	9.	Test the VI characteristics of DIAC.	CO2, CO1
LSO 10.1. Simulate the circuit of TRIAC using EDA tool. *LSO 10.2.* Plot VI characteristics of TRIAC.	10.	Test the VI characteristics of TRIAC.	CO2, CO1
LSO 11.1. Realize the given Boolean expression using logic gates. *LSO 11.2.* Verify its truth table by EDA/simulation tool.	11.	Verify the truth table of different logic gates using appropriate EDA/simulation tool.	CO3, CO1
LSO 12.1. Draw the schematic diagram of adder/subtractor. *LSO 12.2.* Verify its truth table by EDA/simulation tool.	12.	Test the functionalities of adder/subtractor using appropriate EDA/simulation tool.	CO3, CO1
LSO 13.1. Draw the logic diagram of multiplexer/ demultiplexer. *LSO 13.2.* Verify its truth table by EDA/simulation tool.	13.	Simulation of multiplexer, demultiplexer using appropriate EDA/simulation tool.	CO3, CO1
LSO 14.1. Draw the logic diagram of R-S/J-K/D/T flip-flops. *LSO 14.2.* Observe the output waveform.	14.	Simulation of R-S/J-K/D/T flip-flops using appropriate EDA/simulation tool.	CO3, CO1
LSO 15.1. Draw the logic diagram of Modulo-N ripple/synchronous counters. *LSO 15.2.* Observe the output waveform of Modulo-N ripple/synchronous counters.	15.	Simulation of Modulo-N ripple/synchronous counters using appropriate EDA/simulation tool.	CO3, CO1
LSO 16.1. Design R-2R resistive network circuit. *LSO 16.2.* Verify DAC output.	16.	Simulation of R-2R resistive network DAC using appropriate simulation tools.	CO3, CO1
LSO17.1 Determine dc current and dc voltage across component of given circuit.	17.	Simulation of DC circuit for nodal analysis/mesh analysis/ superposition theorem using appropriate EDA/simulation tool.	CO4, CO1
LSO 18.1. Determine DC current /DC voltage and Thevenin's/Norton's equivalent resistance. *LSO 18.2.* Use virtual voltmeter for measuring voltage across given component.	18.	Simulation of DC Circuit for Thevenin's/Norton's equivalent circuit using appropriate EDA/simulation tool.	CO4, CO1
LSO 19.1. Determine AC current and AC voltage across component of RL, RC and RLC in ac circuit. *LSO 19.2.* Use virtual multimeter to measure voltage/current across given component.	19.	Simulation of AC circuit (Series RL, RC & RLC) using appropriate EDA/simulation tool.	CO4, CO1

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 20.1. Draw schematic circuit. *LSO 20.2.* Analyze transient response of series RL, RC & RLC Circuit.	20.	Perform transient analysis of series RL, RC & RLC Circuit using appropriate EDA/simulation tool.	CO4, CO1
LSO 21.1. Determine the voltage ratio of step- up Transformer using EDA tool. *LSO 21.2.* Determine the voltage ratio of step-down Transformer using EDA tool.	21.	Simulation of step up and step-down single-phase transformer using appropriate EDA/simulation tool.	CO4, CO1
LSO 22.1. Observe the continuity for PCB. *LSO 22.2.* Observe the components placement with their line diagram. *LSO 22.3.* Observe the supply node, ground nodes with the use of millimeters.	22.	Practice the following PCB design steps. • Familiarization of the schematic editor • Schematic creation • Annotation • Net list generation	CO5
LSO 23.1. Observe the placements of different components along with buffer and protection circuits. *LSO 23.2.* Construct the PCB layouts with eye on minimizing the electromagnetic interferences, minimum internal path impedances etc.	23.	Practice the following PCB design steps. • Familiarization of footprint editor • Mapping of components • Creation of PCB layout schematic	CO5
LSO 24.1. Construct the half wave rectifiers on PCB using 1N4001 diode with proper resistance value.	24.	Design half-wave rectifier on PCB layout.	CO5
LSO 25.1. Construct the center tapped full wave rectifiers on PCB using 2 diode IC DF10 with proper resistance value. *LSO 25.2.* Construct the full wave bridge rectifiers on PCB using 4 diode IC DF10 with proper resistance value.	25.	Design full-wave rectifier on PCB layout.	CO5
LSO 26.1. Construct the half adder on PCB using proper logic gates ICs 74HC08 (7408) and 74HC86 (7486). *LSO 26.2.* Construct the full adder on PCB using proper logic gates ICs 74LS83 (7483).	26.	Design half adder/full adder using universal gates on PCB layout.	CO5
LSO 27.1. Construct the full adder on PCB using proper logic gates ICs 74HC08 (7408) and 74HC86 (7486).	27.	Design full adder using half adder on PCB layout.	CO5

L) Suggested Term Work and Self Learning: S2421305 Some sample suggested micro projects and other activities arementioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises may be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

i. Draw schematic, simulate and build circuit on general purpose PCB for verifying network theorem.

ii. Design, simulate and build circuit for D.C. motor to rotate in clockwise and anticlockwise direction using transistor.
iii. Design, simulate and build on general purpose PCB to test circuit using opto-coupler for turn ON/OFF fan /light.
iv. Simulate and build circuit using diodes and resistors to display numerals from 0 to 9 on seven segment display.
v. Design, simulate and build circuit to count 10 objects (pulses) for five times.
vi. Simulate and build digital code lock using 16:1 MUX a digital code. Switch turn on when input key code is 3,7,9,12 at output connect solenoid to operate the door.
vii. Design, simulate and build circuit for water level controller using logic gates.
viii. Design and simulate simple emergency light system using any EDA tool.
ix. Design and simulate pressure measurement system using appropriate EDA tool.
x. Design and simulate temperature measurement system using appropriate EDA tool.

c. Other Activities:

1. Seminar Topics:

- Various device design process using simulation tool.
- Various process involved in circuit design process.
- PCB Design

2. Visits: Visit nearby Electrical and Electronics tool room/industry with software facilities. Prepare report of visit with special comments of availability of software for circuit design and software for PCB design.

3. Self-Learning Topics:

- Basics of Circuit Simulation tools
- Basics of P-Spice/LTSpice

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weight age in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work& Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	-	-	10%	-	-	10%	20%
CO-2	-	-	20%	25%	25%	20%	20%
CO-3	-	-	20%	25%	25%	20%	20%
CO-4	-	-	20%	25%	25%	20%	20%
CO-5	-	-	30%	25%	25%	30%	20%
Total Marks	**-**	**-**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:
*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs?

N) Suggested Specification Table for End Semester Theory Assessment: (Not Applicable)

O) Suggested Assessment Table for Laboratory (Practical):

S.No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Installation and operation of the given EDA tool.	CO1	30	60	10
2.	Test the functionalities of positive clipper circuits & negative clipper circuits using appropriate EDA/simulation tool.	CO2, CO1	40	50	10
3.	Test the functionalities of clamper circuits using appropriate EDA/simulation tool.	CO2, CO1	30	60	10
4.	Test the functionalities of half wave rectifier circuit using appropriate EDA/simulation tool.	CO2, CO1	30	60	10
5.	Test the functionalities of center tapped full wave rectifier circuit using appropriate EDA/simulation tool.	CO2, CO1	30	60	10
6.	Test the functionalities of bridge full wave rectifier circuit using appropriate EDA/simulation tool.	CO2, CO1	30	60	10
7.	Test the functionalities of passive filter circuits using appropriate EDA/simulation tool.	CO2, CO1	30	60	10
8.	Test the VI characteristics of SCR.	CO2, CO1	30	60	10
9.	Test the VI characteristics of DIAC.	CO2, CO1	40	50	10
10.	Test the VI characteristics of TRIAC.	CO2, CO1	40	50	10
11.	Verify the truth table of different logic gates using appropriate EDA/simulation tool.	CO3, CO1	40	50	10
12.	Test the functionalities of adder/subtractor using appropriate EDA/simulation tool.	CO3, CO1	30	60	10
13.	Simulation of multiplexer, demultiplexer using appropriate EDA/simulation tool.	CO3, CO1	30	60	10
14.	Simulation of R-S/J-K/D/T flip-flops using appropriate EDA/simulation tool.	CO3, CO1	30	60	10
15.	Simulation of Modulo-N ripple/synchronous counters using appropriate EDA/simulation tool.	CO3, CO1	30	60	10
16.	Simulation of R-2R resistive network DAC using appropriate simulation tools.	CO3, CO1	30	60	10
17.	Simulation of DC circuit for nodal analysis/mesh analysis/ superposition theorem using appropriate EDA/simulation tool.	CO4, CO1	30	60	10

S.No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
18.	Simulation of DC Circuit for Thevenin's/Norton's equivalent circuit using appropriate EDA/simulation tool.	CO4, CO1	30	60	10
19.	Simulation of AC circuit (Series RL, RC & RLC) using appropriate EDA/simulation tool.	CO4, CO1	30	60	10
20.	Perform transient analysis of series RL, RC & RLC Circuit using appropriate EDA/simulation tool.	CO4, CO1	30	60	10
21.	Simulation of step up and step-down single-phase transformer using appropriate EDA/simulation tool.	CO4, CO1	30	60	10
22.	Practice the following PCB design steps. • Familiarization of the schematic editor. • Schematic creation. • Annotation. • Net list generation.	CO5	40	50	10
23.	Practice the following PCB design steps. • Familiarization of footprint editor. • Mapping of components. • Creation of PCB layout schematic.	CO5	40	50	10
24.	Design half-wave rectifier on PCB layout.	CO5	40	50	10
25.	Design full-wave rectifier on PCB layout.	CO5	40	50	10
26.	Design half adder and full adder using universal gates on PCB layout.	CO5	40	50	10
27.	Design full adder using half adder on PCB layout.	CO5	40	50	10

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

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	EDA Tools	EDA tools like eSim/ LTSPICE /TINA/OrCAD/MultiSim/SPICE/ EasyEDA/Circuit Logix/MicroCap /Scilab/MATLAB	All
2.	PCB Design Software	Ki Cad EDA/ Other open-source software	All
3.	Personal Computer	8GB RAM, 500GB HDD, i7 or higher processor	All

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Printed Circuit Board –Design, Fabrication, Assembly & Testing	R.S. Khandpur	McGraw Hill Education,2017ISBN :978-0070588141
2.	Essential Electronic Design Automation	Mark D.Birnbaum,	Prentice Hall, Fourth edition, 2004 ISBN:978-0131828290
3.	Programming in Scilab 4.1	Vinu V. Das	New Age Publication, New Delhi, 2014, ISBN: 978-8122424713
4.	Modeling and simulation using MATLAB	Shailendra Jain	Wiley India Pvt. Ltd., New Delhi, 2014, ISBN: 978-8126551972
5.	Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers	Rudra Pratap	Oxford; Seventh Edition, 2019, ISBN: 978-0190091972
6.	PCB Design and Technology	Walter C. Bosshart	Tata McGraw-Hill, New Delhi, 2002 ISBN: 978-0074515495
7.	Basic Electronics & Linear circuits	N.N. Bhargava, D.C. Kulshreshtha, S.C. Gupta	McGraw Hill Education (India), Noida, 2017, ISBN: 978-1259006463
8.	Network Analysis and Synthesis	S.P. Ghosh A.K Chakrabarti	McGraw Hill Education, New Delhi, 2010. ISBN: 978-0070144781
9.	Electrical & Electronics Measurement	A. H. Sawhney	Dhanpat Rai and Sons, New Delhi, 2012, ISBN: 978-817001006
10.	Modern Digital Electronics	R.P. Jain	McGraw Hill Education, New Delhi, 2009, ISBN: 978-0070669116

(b) Online Educational Resources:

1. https://www.kicad.org/
2. www.esim.fossee.in/
3. www.esim.fossee.in/resources/tutorials/KiCad
4. www.esim.fossee.in/resources/tutorials/Ngspice
5. www.spoken-tutorial.org/tutorial-search/?search_foss=Oscadandsearch_language= English
6. www.linear.com/designtools/software/#LTspice
7. www.tina.com/
8. www.orcad.com/
9. www.ni.com/multisim/
10. www.orcad.com/
11. www.pspice.com/
12. www.linear.com/
13. www.easyeda.com/
14. www.circuitlogix.com/
15. www.spectrum-soft.com/
16. http://esim.fossee.in/resource/book/esimusermanual.pdf
17. www.scilab.org

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Users' Guide
2. Handbook
3. Lab Manuals like Electronics text lab manual, Paul B. Zbar

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A) Course Code : 2421306(P2421306/S242136)

B) Course Title : Summer Internship -I (Common For all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

Diploma students are required to give exposure of their own diploma programme related industrial hardware, software and practices, just after completing one semester, so that they can correlate this industrial exposure with the concept being taught in the branch specific specialized engineering courses in forthcoming semesters. Mentors/ s/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the 'Whole to Part' approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the diploma programme – and then teaching the related concepts ('Part') of the same in subsequent semesters. In this way before actually being exposed to academic input specific to diploma programmes, the students need to be sent to the nearby/local industries and also may be advised to explore information related to their programme of study using different sources related to potential employment opportunities of both wage and self-employment, job function, job position, nearby relevant industries and so on.

The summer internship will provide the direction to the students and also help in mind mapping to plan their futuristic course of action, after passing the diploma. This would also bridge the gap between their virtual imagination about the outcome of the programme and real happenings related to the diploma programme.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

- **CO-1** Comprehend the practices of identified industry or world of work related to diploma engineering programme of study.
- **CO-2** Map real equipment, processes, product, management, operations etc. to the course of study through various glimpses of input, process and output in different type of industries.
- **CO-3** Identify the probable enterprises /startups for futuristic planning and self-growth.
- **CO-4** Identify the probable job function and job position in their relevant programme of study.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	-	1	-	-	1		
CO-2	3	-	-	1	-	-	1		
CO-3	3	-	-	-	1	-	2		
CO-4	3	-	-	-	1	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

***** PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2421306	Summer Internship -I	-	-	02	02	04	02

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2421306	Summer Internship -I	-	-	10	15	10	15	50

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) **Suggested Instructional/Implementation Strategies:** Mentors/ Coordinators/ Teachers need to plan and implement the summer internship in their respective programme as per the outcome expected from the programme. However in general, summer internship would help in exploring and exposing the student to the below mentioned dimensions of the world of work. These dimensions can further be explored in depth as per the need and advancement in respective programmes in later stages. Mentors/Coordinators/ Teachers need to map the academic contents of the programme of study with the activities of this industrial exposure and are advised to follow the whole to part approach to make the students aware about the potential industry's expected outcomes & setup ('Whole') from the specific diploma programme and then teaching the related concepts ('Part') of the same in subsequent semesters.

- Industrial Layout
- Organizational Structure
- Corporate Communications
- Strategic, Rolling and Developmental plans
- Maintenance Procedures
- Inventory Control and Management System
- Purchase and Store Procedures
- Major Machinery, Tools, Equipment, Devices, Software, Control System etc.
- Product Development, Manufacturing, Packaging and Delivery
- Project Management
- Operation and Maintenance
- Warehouse Management
- Assembly Line
- Quality Assurance and Testing Cell
- Process/ Software Development/ Fabrication/ Construction Work Management
- Testing and Quality Assurance Practices
- Total quality management
- Calliberation and Certification practices
- Safety Practices
- Industrial Acts
- Industrial Grievances
- Behavioural Aspects
- Conduction of Meetings and Discussions
- Sales and Marketing Strategies
- Forecasting and Target Setting
- Production Planning and Control
- Storage Retrieved and Material handling Practices
- Automation and Control Facilities
- Enterprise Resource Planning (ERP)
- Supply Chain
- Customer Satisfaction Strategies
- Finance and Accounts
- Research and Development
- Promotion and Capacity Building Schemes
- Reduce, Reuse and Recycling Efforts and Policies
- Recognitions and Rewards
- After Sale Services
- Promotional Avenues
- Social Corporate responsibilities

J) Assessment of Summer Internship -I

S. No.	Criteria of Assessment	% of Weightage
1.	Maintaining the log book after having exposure to different types of industry/ world of work	15
2.	Preparing the list of job functions and job positions of relevant programme	20
3.	Identify the probable enterprise/ startup for futuristic planning	15
4.	Report writing of summer internship as per the prescribed format	30
5.	Presentation of Report	20
Total		**100**

Note: S. no. 1 to 3 shall be considered for progressive assessment. While S. No. 4 & 5 shall be considered for end term assessment

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A) Course Code : **2400308(T2400308/S2400308)**

B) Course Title : Essence of Indian Knowledge System and Tradition
(Common for all Programmes)

C) Pre- requisite Course(s) :

D) Rationale :

This course will survey the basic structure and operative dimensions of Indian knowledge system. With the new education policy-NEP 2020 focusing on Indian Knowledge Systems (IKS) and Traditions of India. This course introduces the learners to the rich and varied knowledge traditions of India from antiquity to the present. This also helps the learner to know and understand their own systems and traditions which are imperative for any real development and progress. Also, it helps the learner to think independently and originally adopting Indian frameworks and models for solving the problems related to world of work where the student is supposed to perform.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course out comes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Identify the rich heritage and legacy residing in our Indian Knowledge systems.

CO-2 Correlate the technological & philosophical concepts of IKS with engineering domain specific problems and local problems for finding out possible solutions.

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	2	-	-	-	1	1	1		
CO-2	1	2	2	-	3	1	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

* PSOs will be developed by the respective program coordinator at the institute level. As per the latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Course Code	Course Title	Scheme of Study (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits (C)
		L	T				
2400308	Essence of Indian Knowledge System and Tradition	01	-	-	-	01	01

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture(L), Tutorial(T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits= (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
		Theory Assessment (TA)		Term Work& Self-Learning Assessment (TWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2400308	Essence of Indian Knowledge System and Tradition	25	-	25	-	-	-	50

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) 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), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:T2400308

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the architecture of the Ancient Indian Knowledge Systems. *TSO 1b.* List the salient features of IKS. *TSO 1c.* Comprehend the given IKS model. *TSO 1d.* Identify the role and relevance of the given IKS model in contemporary society.	**Unit-1.0 Introduction to Indian Knowledge Systems** 1.1 Overview of IKS 1.2 Organization of IKS 1.3 Conception and Constitution of Knowledge in Indian Tradition 1.4 The Oral Tradition 1.5 Models and Strategies of IKS	**CO1**
TSO 2a. Enlist the importance of Veda, Vedanga, Visaya, Siksaka. *TSO 2b.* Describe the given IKS domain. *TSO 2c.* Identify elements of mentioned IKS domains that are relevant to Technical Education System. *TSO 2d.* Correlate the elements of mentioned IKS domains with given engineering domain.	**Unit-2.0 Overview of IKS Domains and Relevance in Current Technical Education System.** 2.1 The Vedas as the basis of IKS 2.2 Overview of all the six Vedāṅgas 2.3 Relevance of following IKS domains in present Technical Education System: • Arthashastra (Indian economics and political systems) • Ganita and Jyamiti (Indian Mathematics, Astronomy and Geometry • Rasayana (Indian Chemical Sciences) • Ayurveda (Indian Biological Sciences / Diet & Nutrition) • Jyotish Vidya (Observational astronomy and calendar systems) • Prakriti Vidya (Indian system of Terrestrial/ Material Sciences/ Ecology and Atmospheric Sciences) • Vastu Vidya (Indian system of Aesthetics- Iconography and built-environment /Architecture) • Nyaya Shastra (Indian systems of Social Ethics, Logic and Law) • Shilpa and Natya Shastra (Indian Classical Arts: Performing and Fine Arts) • Sankhya and Yoga Darshna (Indian psychology, Yoga and consciousness studies) • Vrikshayurveda (Plant Science / Sustainable agriculture/food preservation methods)	**CO1, CO2**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) Suggested Term Work and Self Learning: S2400308 Some sample suggested assignments, micro project and otheractivities are mentioned here for reference.

a. Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. Micro Projects:

1. Write a report on any IKS domain highlighting the correlation with one domain specific engineering course.

c. Other Activities:

1. Seminar Topics: discuss any one IKS domain in details a highlighting the eminent works in the area.
2. Visits:
   - Visit any nearby ancient temple and corelate the geomatical, Shilpa and Vaastu on IKS dimensions specified in each domain.
3. Self-Learning Topics:
   - Sustainable practices adopted in ancient India that can be applied for current engineering situations.

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	-	-	-	-	-	-	-
CO-2	100%	-	100%	100%	100%	-	-
Total Marks	25	-	5	10	10	-	-
			25				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: (Not Applicable)

O) Suggested Assessment Table for Laboratory (Practical): (Not Applicable)

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Indian Knowledge System: Concepts and Applications	Archak, K.B. (2012).	Kaveri Books, New Delhi
2.	Introduction to Indian Knowledge System: Concepts and Applications	Mahadevan, B. Bhat, Vinayak Rajat Nagendra Pavana R.N.	PHI, ISBN: 9789391818203
3.	Glimpse into Kautilya's Arthashastra	Ramachandrudu P. (2010)	Sanskrit Academy, Hyderabad
4.	"Introduction" in Studies in Epics and Purāṇas, (Eds.)	KM Munshi and N Chandrashekara Aiyer	Bhartiya Vidya Bhavan

(b) Online Educational Resources:

1. http://bhavana.org.in
2. www.academia.edu/23254393/Science_in_Ancient_India_-_an_educational_module
3. www.academia.edu/23305766/Technology_in_Ancient_India_-_Michel_Danino
4. www.hamsi.org.nz/http://insaindia.res.in/journals/ijhs.php
5. www.niscair.res.in/sciencecommunication/ResearchJournals/rejour/ijtk/ijtk0.asp
6. www-history.mcs.st-andrews.ac.uk/Indexes/Indians.html

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Swami Harshananda. "A bird's eye view of vedas". R K Math. Bangalore.,http:// rkmathbangalore. org/Books/ABirdsEyeViewOfTheVedas.pdf.
2. Sanskrit Prosody, https://en.wikipedia.org/wiki/Sanskrit_prosody.
3. Vartak, P.V. (1995). "Veda and Jyotish," Part II, Chapter 2, in Issues in Veda and Astrology, H Pandya (Ed.), pp 65 – 73.
4. Sundaram, A.V. (1995). "Astrology: Its usefulness and Limitations in ModernTimes", Part II, Chapter 9, in Issues in Veda and Astrology, H Pandya (Ed.), pp 129 – 135.
5. Archak, K.B. (2012), "The Vedāṅga Literature", Chapter VIII in Essentials of Vedic Literature, Kaveri Books, New Delhi, pp 330 – 391.
6. Vasant Lad (1996), "Ayurveda: A Brief Introduction and Guide", (whole article).

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