Curriculum of Diploma Programme

in

Electronics and Electrical

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
2474305		**EDA Tools & MATLAB Application**			04	02	06	03
2400308	**NRC**	**Essence of Indian Knowledge System and Tradition** (Common for All Programmes)	01	-	-	-	01	01
2421306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	02	02	04	02
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**	30	70	20	30	20	30	200
2421304	**PCC**	**Principles of Electronic Communication**	30	70	20	30	20	30	200
2474305		**EDA Tools & MATLAB Application**			20	30	20	30	100
2400308	**NRC**	**Essence of Indian Knowledge System and Tradition**	25	-	25	-	-	-	50
2421306	**PSI**	**Summer Internship – I** (After 2nd Sem) (Common for all programmes)	-	-	10	15	10	15	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 activitieslike 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)

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 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.

*****

A) Course Code : **2420304(T2420304/S2420304)**

B) Course Title **:** Electrical Power Generation, Transmission and Distribution

C) Pre- requisite Course(s) **:** Basic Electrical Engineering, Electrical Circuit and Networks, DC Machines and Transformers

D) Rationale :

Electrical power plays a significant role in the development of industries and agriculture. With growing demand of electric power and diminishing fossil fuels, it has become imperative to generate power more efficiently. This course therefore deals in detail not only about generation of electric power using thermal (coal), hydro, nuclear fuel and diesel but also about transmission and distribution and also about deregulation of power system. The generating power plants needs highly skilled technicians who are capable of operating and maintaining various control equipment to generate, transmit and distribute power effectively and efficiently. This course attempts to develop the basic cognitive skills required to take appropriate steps/decisions to maintain the various and auxiliary equipment of power plants, transmission and distribution system.

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 Maintain Thermal, Hydro, Nuclear and Gas based Electrical Power Generating plants for its efficient operation.

CO-2 Maintain Electrical Power Generating Plants based on Renewable Energy Sources for its efficient operation.

CO-3 Maintain Electrical Power Transmission System.

CO-4 Maintain Electrical Power Distribution System.

CO-5 **I**nterpret the restructuring process and structure of Deregulated Power System.

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	1	2		
CO-2	3	2	2	2	2	1	2		
CO-3	3	2	2	2	2	1	2		
CO-4	3	2	2	2	1	2	2		
CO-5	3	2	1	-	2	2	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				
2420304	Electrical Power Generation, Transmission and Distribution	02	01	-	02	05	04

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)	
2420304	Electrical Power Generation, Transmission and Distribution	30	70	20	30	-	-	150

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:

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: T2420304

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe the layout of the given type of power plant for electric power generation with labeled block diagram. *TSO 1b.* Explain the working of the given type of power plant with sketches. *TSO 1c.* Describe the criteria considered for site selection of the given power plant. *TSO 1d.* State the functions of different components of the given type power plant. *TSO 1e.* Explain the properties of the fuel used in the specified thermal power plants. *TSO 1f.* Describe the energy conversion process in the given type of power plants *TSO 1g.* State the given terms related to Power generation plants. *TSO 1h.* Explain the given factors which affects the economics of electric power generation.	**Unit-1.0 Generation of Electrical Power** **1.1 Thermal Power Plant**: Lay out, working and Site selection. • Major Auxiliaries: Functions • Properties of conventional fuels used in Thermal Power Plants **1.2 Hydro Power Plants:** Elements of Hydro power plant, Energy conversion process, Layout, and Site selection, Classification **Nuclear power Plant**: Lay out, working and site selection Properties of conventional fuels used in nuclear power plants, safe practices in nuclear power plants, Types of nuclear reactors, Disposal of nuclear waste and nuclear shielding. **1.4 Gas power plant**: Lay out, working and site selection Other features of Power generation Plants: Connected load, firm power, cold reserve, hot reserve, spinning reserve. Factors affecting cost of generation: Average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor. Base load and peak load plants; Load curve, load duration curve, integrated duration curve.	**CO1**
TSO 2a. Describe with sketches the layout and working of the solar energy power plant. *TSO 2b.* Describe with sketches the layout and working of the wind energy power plant. *TSO 2c.* Describe with sketches the layout and working of the Bio-mass based power plants. *TSO 2d.* Describe with sketches the layout and working of the Geo-thermal energy power plant. *TSO 2e.* Describe with sketches the layout and working of the Ocean energy power plant. *TSO 2f.* Describe the layout and working of the Fuel cell with sketches.	**Unit-2.0 Renewable Energy Sources** 2.1 Types of Renewable Energy Sources. 2.2 Solar Energy: Potential of solar energy, Photovoltaic effect, Construction & materials used in solar photo-voltaic cells, working & applications of solar energy. 2.3 Wind Energy: Selection of site for wind mills, Working Principle, Block diagram, Applications 2.4 Bio-Mass & Bio-Gas Energy: Composition of Bio-Gas & its calorific value, Traditional and non-traditional Biogas plants, Bio-mass based power generation plants, their capacities and applications 2.5 Geo-thermal Energy: Working Principle, Block Diagram and applications. 2.6 Ocean Energy: Ocean Thermal Electric Conversion, Energy from Tides, Site requirements, Advantages and Limitations of Tidal power generation. 2.7 Fuel Cells: Construction, working types and applications	**CO1, CO2**
TSO 3a. Explain the effects of R, L and C on the given transmission line. TSO 3b. Explain the features of given type of transmission lines TSO 3c. State the features of different types of conductors. TSO 3d. State the need for different types of insulators and calculate string efficiency	**Unit-3.0 Transmission of Electrical Power** 3.1 Transmission Line Parameters: Resistances, Inductances and Capacitances 3.2 Classification of Transmission Lines: short, medium and long 3.3 Comparison of different types of transmission systems.	**CO2, CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
of given type of insulators. TSO 3e. Describe the given method of improving string efficiency of insulators. TSO 3f. Explain the criteria for spacing of conductors TSO 3g. Calculate sag in given type of transmission system. TSO 3h. Explain the phenomena of corona and factors affecting it in given type of transmission line. TSO 3i. Explain different phenomena occurred in given transmission line. TSO 3j. Calculate the performance parameters single phase short transmission line. TSO 3k. Explain the importance and functions of the load dispatch Centre. *TSO 3l.* State the salient features of the given EHV transmission *system.*	3.4 Types of Conductors-Copper, Aluminum: Solid, stranded and bundled conductors. 3.5 Line Insulators – requirements, types, Failure of insulator. 3.6 String Efficiency, string efficiency improvement method: By using longer cross arm, by grading the insulator and by using guard ring 3.7 Spacing between Conductors, span length and sag calculation. 3.8 Corona – corona formation, advantages & disadvantages, factors affecting corona 3.9 Skin effect, proximity effect, Ferranti effect and Transposition of conductors. 3.10 Losses, efficiency, regulation and Effect of load power factor 3.11 Load dispatch Centre 3.12 Issues of Distributed Generation Integrated to distribution Grid. 3.13 Requirement of EHV transmission. - HVAC Transmission - HVDC Transmission	
TSO 4a. State the need for distribution system. TSO 4b. Describe the various connection schemes of the distribution system with sketches. TSO 4c. Calculate voltage drop and minimum potential point using the given methods for 1-phase and 3-phase distribution system. TSO 4d. Describe the measures to be adapted to take of the distributed generation in the distribution system. TSO 4e. State the need for electrical substations and relevant site for given substation. TSO 4f. Sketch the elevation layout of a typical 11/33kV electrical substation with various switchgear and typical spacing between them and the ground level as well. TSO 4g. Describe the installation procedure of substation equipment's. TSO 4h. State the features of unarmored and armored underground cables TSO 4i. Describe the given laying procedure for underground cable.	**Unit-4.0 Electrical Power Distribution System** 4.1 Distribution system and its Requirements. 4.2 Connection schemes of distribution system. 4.3 A.C. distribution: Voltage drop, sending end voltage, receiving end voltage, point of minimum potential, minimum potential value and power loss 4.4 Power factor referred to receiving end voltage and power factor referred to respective load voltage. 4.5 Substation: Classification of substations based on; voltage level and Type of installation. 4.6 Selection and location of site for substation. 4.7 Installation of substation equipment. 4.8 Underground Cables**:** Requirements, classification, construction, comparison with overhead lines. 4.9 Laying of underground cable: Direct laying, Draw in system and Solid system	**CO3, CO4**
TSO 5a. State the concept and purpose of deregulation in power industry. TSO 5b. State the reasons for adopting deregulation in development of power industry. TSO 5c. Explain the process involved in restructured power system. TSO 5d. State the functions of the given ancillary support system. TSO 5e. State issues involved in deregulation process.	**Unit-5.0 Deregulated Power system** 5.1 Introduction. 5.2 Reasons for restructuring/ deregulation of power system. 5.3 Objectives of deregulation of various power system across the world. 5.4 Restructuring process 5.5 Ancillary services: Frequency support ancillary services, voltage control ancillary services and black start ancillary services 5.6 Issues involved in deregulation.	**CO4, CO5**

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: S2420304 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

i. Enlist the merits and demerits of Thermal Power Plant over Hydroelectric plant.
ii. Draw the layout of a typical thermal, Hydro and Nuclear plant
iii. Prepare the current installed and generating capacity of various renewable energy sources in India
iv. Sketch different components of transmission line and explain the purpose of each in detail.
v. Calculate inductance value of a given transmission line.
vi. Calculate capacitance value of a given transmission line.
vii. Solve problems on string efficiency and sag.
viii. Prepare report on Power Cable Jointing procedure of unarmoured and armoured power cable.
ix. Calculate the performance of given transmission line.
x. Estimate the string efficiency of the given type of insulators.
xi. Illustrate the ancillary services, reform initiatives and open access issues in Deregulated Power Industry

b. Micro Projects:

i. Identify the different parts of thermal power plant using video/ site visit etc. and Prepare a report on generating capacity of any Thermal Power Plant describing installed capacity of turbine, Generator etc.
ii. Observe the operation of thermal power plant using video programme and prepare report on it.
iii. Identify the different parts of Nuclear power plant using video/ site visit etc. and Prepare a report on generating capacity of any Nuclear Power Plant describing installed capacity of turbine, Generator etc.
iv. Observe the operation of Nuclear power plant using video programme and prepare report on it.
v. Identify the different parts of Hydro power plant using video/ site visit etc. and Prepare a report on generating capacity of any Hydro Power Plant describing installed capacity of turbine, Generator etc.
vi. Observe the operation of Hydro power plant using video programme and prepare report on it.
vii. Identify the different parts of Wind power plant using video/ site visit etc. and Prepare a report on generating capacity of any Wind Power Plant describing installed capacity of Generator etc.
viii. List the types of Insulators used in Power Transmission and Distribution System and prepare chart on its uses.
ix. Collect the data from nearest power station/substation for load curve preparation and interpret it.
x. Prepare a report on different type of insulators and conductors used in transmission system with their specifications.
xi. Prepare a chart on different types of power cables used in transmission and distribution system showing its classification and specific applications.
xii. Find out the availability of the various transmission and distribution components and comparison of their specification and prices after market survey.
xiii. Prepare a model of a substation.
xiv. Prepare a model for generation of electricity using wind power.
xv. Prepare a model for generation of electricity using solar power
xvi. Prepare technical report after visiting a nearby Solar PV station.
xvii. Prepare technical report after visiting a nearby Wind Power station.

c. Other Activities:

a) Seminar Topics:
- Types of Turbine used in Thermal and Hydro Power Plant.
- Types of alternators used in Thermal and Hydro Power Plant.
- HVAC and HVDC Transmission System.
- Power transmission by BSPTCL
- Ancillary Services.

b) Visits:
- Visit a nearby Solar Power Plant and draw a general layout of the solar PV system Installation and prepare report on the Installation arrangement of different parts/components of it.
- Visit a nearby power station/ substation and draw a general layout of the electrical power system and prepare a report on types of supporting structure used in transmission and distribution system with their power ratings.
- Visit to nearby power station/substation. Prepare report of visit with special comments on transmission and distribution line components used, technique used, material used and unit charge of energy produced.
- Visit to 66 kV distribution sub-station and draw line diagram with equipment specifications.
- Visit 132/220/400kV transmission sub-station and draw line diagram with equipment specifications.
- Visit to a nearby Load Dispatch Centre and prepare Technical Report on it.
- Visit to nearby Electrical Power Generation Station and prepare Technical report on it.

c) Self- Learning Topics:
- Flexible AC Transmission Line
- Dry Transformers.
- DC Distribution System.
- Gas Insulated Substation
- Flexible Ac transmission line
- Smart grid
- Underground Transformer Installation.

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	30%	30%	10%	100%	20%	-	-
CO-2	20%	20%	10%		20%	-	-
CO-3	20%	20%	40%		20%	-	-
CO-4	20%	20%	30%		20%	-	-
CO-5	10%	10%	10%		20%	-	-
Total Marks	**30**	**70**	**20**	**20**	**10**	**-**	**-**
			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:** 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 Generation of Electrical Power.	14	CO1	20	5	7	8
Unit-2.0 Renewable Energy Sources.	9	CO2	14	4	5	5
Unit-3.0 Transmission of Electrical Power	10	CO3	14	4	5	5
Unit-4.0 Electrical power Distribution System	9	CO4	14	4	5	5
Unit-5.0 Deregulated Power system	6	CO5	08	3	3	2
Total Marks	**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): (Not Applicable)

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
1.	Simulation model/software for demonstrating the parts and working of various power generating plants	Thermal, Hydro, Nuclear, Solar, Wind
3.	Transmission line simulator (Short, Medium and Long)	• Single-phase and three-phase lines • Six-section three-phase line • Resistive, inductive and capacitive loads • Over current protection relay
4.	Different types of overhead line Insulators	Disc type, pin type, shackle type
5.	Different types of underground cables	Armoured and un armoured

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Power Plant Engineering	P K Nag	McGraw Hill, New Delhi, ISBN:978-9339204044
2.	A Course in Electrical Power	JB Gupta	S K Katarina and Sons, New Delhi.2014, ISBN:9789350143742
3.	Generation of Electrical Energy	B.R. Gupta	Chand &Co New Delhi, 2010 ISBN: 9788121901024
4.	Electrical Power Systems	Dr. S.L. Uppal and Prof. Sunil S. Rao	Khanna Publishers ISBN: 978-8174092380
5.	A Course in Electrical Power	Sony, Gupta, Bhatnagar	Dhanpat Rai and Sons, New Delhi, 2010 ISBN: 9789350143742
6.	Principles of Power System: including generation, transmission, distribution switchgear and protection	Mehta V K Rohit Mehta	S. Chand & Company Pvt. Ltd., New Delhi ISBN: 978-8121924962
7.	A Textbook of Electrical Technology Vol. III	Theraja, B.L.; Theraja, A.K.	S.Chand and Co. New Delhi ISBN: 9788121924900
8.	Power System Engineering	D.P. Kothari & I.J. Nagrath	McGraw-Hill; ISBN: 978-0070647916
9.	Operation of Restructured Power Systems (Power Electronics and Power Systems)	Kankar Bhattacharya, Jaap E. Daadler, Math H. J. Boolen, Kluwer	Springer; 2001 edition (October 26, 2012) ISBN-10 : 1461355672 ISBN-13 : 978-1461355670

(b) Open Educational Resources:

1. https://archive.nptel.ac.in/courses/112/107/112107291/
2. https://archive.nptel.ac.in/courses/108/102/108102047/
3. http://www.nptelvideos.in/2012/11/power-sys-generation-transmission.html
4. http://www.nptelvideos.in/2012/11/energy-resources-and-technology.html
5. www.tpud.org/.../An_Introduction_to_Electric_Power_Transmission_Presentation.pdf
6. www.nct-tech.edu.lk/Download/.../Performance%20of%20Transmission%20Lines..pd.
7. https://www.electrical4u.com/performance-of-transmission-line/
8. https://energy.gov/sites/prod/files/2013/07/f2/Transmission_Woodall_0.pdf
9. https://www.youtube.com/watch?v=_HxM6DAYQ4U
10. https://www.youtube.com/watch?v=CLEptMD9-EI
11. https:// https://www.youtube.com/watch?v=ns7FrGHBAFw
12. https://www.academia.edu/22504154/Power_System_Generation_Transmission_and_Distribution
13. http://nptel.iitm.ac.in/courses/108101005

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. Electric power engineering handbook on Electric Power Generation, Transmission and Distribution, CRC Press
2. Users' Guide
3. Manufacturers' Manual of power plant equipment
4. Lab Manuals

*****

A) Course Code : **2420303(T2420303/P2420303/S2420303**)

B) Course Title **:** DC Machines and Transformers

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

D) Rationale :

The technological changes are taking place very rapidly all over the world and is turning towards a multidisciplinary one. Electrical Engineering diploma holders are expected to apply the principle of electromechanical energy conversion in operating, testing and troubleshooting different types of DC machines, single phase & three phase transformers and special purpose transformers. This course will enable them to develop requisite knowledge, skills and attitude for maintaining various types of DC machines, single phase transformers, three phase transformers and special purpose transformers taking appropriate safety measures during handling of these equipment. This course fundamentally aims at familiarizing the students with the fundamentals of various DC machines, single phase and three phase transformer and development of requisite skills for maintaining this equipment. This course will also provide a strong foundation of DC Machines and Transformers and will enable the students to take up the advance course in electrical machines in the subsequent semester.

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** Test the performance of DC Generators.
- **CO-2** Control the speed of DC motors as per the requirement.
- **CO-3** Test the performance of Single-Phase transformers.
- **CO-4** Operate two three phase transformers in parallel as per the requirement.
- **CO-5** Use special purpose transformers as per the requirement.

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	1	2		
CO-2	3	2	2	2	-	1	2		
CO-3	3	2	2	2	2	1	2		
CO-4	3	2	2	2	2	2	2		
CO-5	3	2	2	2	-	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				
2420303	DC Machines and Transformers	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)	
2420303	DC Machines and Transformers	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.
- 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 (SW) 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 thecompletion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Society connect, Multidisciplinary aspects, Indian Knowledge System (IKS) and others need to be integrated.

J) Theory Session Outcomes (TSOs) and Units: T2420303

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1.a Describe the construction details of a DC machine. TSO.1.b Explain the working principle of the DC Generator. TSO.1.c Classify DC Generator. TSO.1.d Explain effect of armature reaction in a DC machine. TSO.1.e Explain the process of commutation in DC Generator. TSO.1.f Describe the procedural steps of voltage build up in the DC generator. TSO.1.g Interpret the internal and external Characteristics of the given DC Generators.	**Unit-1.0 DC Generators** 1.1 DC Machine: Construction 1.2 DC Generator: Working Principle 1.3 Types of DC generators: Shunt, Series and Compound and their applications 1.4 EMF equation 1.5 Armature reaction and its effects. 1.6 Commutation. 1.7 Voltage build-up in DC Generators 1.8 Internal and External Characteristics. 1.9 Losses and Efficiency	**CO1**
TSO.2.a Explain the working principle of DC motor. TSO.2.b Determine the torque for a given DC motor TSO.2.c Interpret the various characteristics of DC motor TSO.2.d Describe the procedure to start the DC motor using given type of starters. TSO.2.e Describe the procedure to control the speed of the given DC motor. TSO.2.f Describe the procedure to select a particular DC motor for the given application. TSO.2.g Enlist the applications of different types of motors including applications in modern transportation systems.	**Unit-2.0 DC Motors** 2.1 Working Principle. 2.2 EMF equation, significance of Back EMF 2.3 Torque and Speed 2.4 Characteristics of DC motors - Torque vs Speed, Flux vs Current - Torque vs current, Speed vs Current 2.5 Need of Starters -3-point and 4-point starters. 2.6 Losses and Efficiency 2.7 Speed Control of DC motors - Armature Control Method - Field Flux Control Method 2.8 Selection of DC Motors. 2.9 Applications of different types of DC motors	**CO1, CO2**
TSO.3.a Describe the constructional details of a single-phase transformer. TSO.3.b Explain the working principle of transformer. TSO.3.c Derive EMF equation of a single-phase transformer. TSO.3.d Calculate various losses using Open circuit and Short circuit test. TSO.3.e Differentiate Ideal and Practical transformer. TSO.3.f Explain the performance with phasor diagram of the given transformer under no load and different loading conditions for unity, lagging and leading power factor TSO.3.g Explain the importance of voltage regulation. TSO.3.h Explain the condition of maximum efficiency of a transformer. TSO.3.i Describe the procedure of performing the Polarity test, Open circuit, Short Circuit Test in the given transformer. TSO.3.j Enlist the essential and desirable conditions for parallel operation of two single phase transformers. TSO.3.k Differentiate between autotransformer and	**Unit 3.0 Single Phase Transformer** 3.1 Construction. 3.2 Types -Shell type and core type. 3.3 Working Principle, Useful and leakage flux 3.4 EMF Equation, Transformation Ratio. 3.5 Losses – Core and copper 3.6 Ideal and Practical transformer. 3.7 Equivalent circuit and phasor diagram. 3.8 Per Unit (pu) system in transformers 3.9 Voltage Regulation -Condition for maximum, zero and minimum regulation. 3.10 Efficiency -Condition for Maximum Efficiency, All day efficiency and its significance 3.11 Polarity test, Open circuit, Short Circuit Test 3.12 Parallel operation of two single transformers. 3.13 Autotransformers -Construction, application, Inductive and conductive power transfer, Copper saving.	**CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
two winding transformers. TSO.3.l Explain the significance of Amorphous Metal Transformer (AMT).	3.14 Energy efficient Amorphous Metal Transformer (AMT).	
TSO.4.a Describe the constructional details of 3-phase transformer. TSO.4.b Classify the different phasor groups of 3-phase transformer TSO.4.c Explain the working of open delta transformer. TSO.4.d Enlist the essential and desirable conditions for parallel operation of two 3-phase transformer. TSO.4.e Explain the Magnetization phenomenon in Transformer.	**Unit 4.0 Three Phase Transformer** 4.1 Bank of three single phase transformer and single unit of 3-phase transformer 4.2 Different parts of 3-phase transformers 4.3 Phasor groups of 3-phase transformers 4.4 Open Delta transformer 4.5 Parallel Operations of two 3-phase transformers 4.6 Magnetization phenomenon in Transformer.	**CO3, CO4**
TSO.5.a Explain the construction and working principle of the given special purpose transformers. TSO.5.b Describe the basic testing Procedure of the given special purpose transformers. TSO.5.c State the applications of the given special purpose transformers.	**Unit 5.0 Special Purpose Transformers** 5.1 Isolation Transformer 5.2 Grounding Transformer 5.3 Instrument transformer 5.4 Current Transformer 5.5 Potential Transformer 5.6 Welding transformer	**CO4, CO5**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2420303

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Identify different parts of a DC machine.	1.	Identification of parts of a DC Machine by dismantling the cut section model of a DC machine	CO1
LSO 1.2 Interpret the effect of speed and field flux on generated voltage of DC shunt generator.	2.	Effect of speed and field flux on generated voltage of DC shunt generator	
LSO 1.3 Test the performance of DC shunt generator on the given load condition.	3.	Load test of DC shunt Generator	
LSO 1.4 Test the performance of DC series generator on the given load condition.	4.	Load test of DC series Generator	
LSO 2.1 Use appropriate DC motor starter for starting the given DC Motor.	5.	Starting of D. C shunt motor using 3-point /4-point starter	CO1, CO2
LSO 2.2 Change e terminal connection of DC shunt motor and observe the direction of rotation	6.	Reversal of Direction of a DC Shunt motor	
LSO 2.3 Control speed of DC Shunt motor using field/flux control method (Above rated speed)	7.	Speed control of D.C shunt motor	
LSO 2.4 Control speed of DC Shunt motor using armature control method (Below rated speed).	8.	Speed control of a D.C. Shunt motor	
LSO 2.5 Test performance of DC shunt motor on the given load condition.	9.	Load test of D. C. shunt motor	

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.6 Test performance of DC series motor on the given load condition.	10.	Load test of D.C. series motor	
LSO 2.7 Apply direct method to brake the DC shunt motor.	11.	Brake test of D.C. shunt motor.	
LSO 3.1 Measure voltage and current ratio of a given single phase transformer	12.	Measurement of voltage and current ratio of a given single phase transformer.	CO3
LSO 3.2 Test polarity of the given single phase transformer.	13.	Polarity of a single-phase transformer	
LSO 3.3 Test performance of a given transformer by direct load test.	14.	Direct load test on a single-phase transformer	
LSO 3.4 Observe the no load waveform of a given transformer using CRO	15.	No load waveform of a transformer using CRO	
LSO 3.5 Perform Open Circuit and Short Circuit test on a single-phase transformer.	16.	Open Circuit and Short Circuit test on a single-phase transformer.	
LSO 3.6 Perform parallel operation of two 1-phase transformer having equal and unequal KVA rating under given load.	17.	Parallel operation of two single phase transformers.	
LSO 3.7 Test performance of an auto transformer and 1-phase two winding transformer of same rating.	18.	Auto transformer and 1-phase two winding transformer of same rating	
LSO 4.1 Perform parallel operation of two 3-phase transformer having equal and unequal load sharing for a given load.	19.	Parallel operation of two three phase transformers for equal and unequal load sharing.	CO3, CO4
LSO 5.1 Measure current ratio of the given Current transformer using ammeter/clamp meter.	20.	Current ratio of a Current transformer	CO4, CO5
LSO 5.2 Measure voltage ratio of the given Potential transformer using voltmeter.	21.	Voltage ratio of a Potential Transformer	CO4, CO5

L) Suggested Term Work and Self-Learning: S2420303 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

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

i. Prepare a chart to depict Flemings right hand rule as applicable to DC Generator and Flemings left hand rule as applicable to DC Motor with labeled sketches
ii. Prepare a chart indicating detailed classification of DC machines with labeled sketches
iii. Prepare a chart depicting the working of 3-Point DC shunt motor starter highlighting the inbuilt protective devices in the starter using a labeled sketch.
iv. Prepare a chart depicting the working of 4-Point DC shunt motor starter highlighting the inbuilt protective devices in the starter using a labeled sketch.
v. List the precautions to be taken while starting a DC series and shunt motor with reasons.
vi. Prepare a chart depicting the various parts of a transformer drawing neat labeled sketch.
vii. Draw core and shell type of transformers highlighting the difference between them.
viii. List out the applications of single phase and three phase transformers, auto-transformer and wielding transformer.
ix. Collect the information (specification, and use) and prepare a report on three phase three winding transformers based on information collected from different manufacturers.

x. Prepare a chart displaying the various routine tests performed on a three-phase transformer as per IS.
xi. Compare a bank of 3 single phase transformers with that of 3 phase transformers.
xii. List out the applications of single phase, three phase transformers, auto-transformer and wielding transformer.

b. Micro Projects:

1. Fabricate single loop DC generator and observe the generated wave form on CRO.
2. Use suitable DC generator for arc welding purpose and prepare a detailed report including selection of generator, connection and operation with safety precautions followed during use.
3. Prepare a report on strategies to start a given DC motor without conventional starters.
4. Build a Bridge rectifier using diodes of appropriate rating to provide supply to a DC Machine
5. Investigate whether OC & SC test or direct load test is preferred for determining the performance of a transformer
6. Fabricate and test a step-up or step-down transformer and submit detailed report on it.
7. Visit nearby sub-station and list out the main cause of brake-down of distribution transformer and propose strategies to reduce its failures.
8. Develop a three-phase transformer using three single phase transformer and compare its performance with a poly phase transformer.

c. Other Activities:

1. Seminar Topics-

- DC Generators and its application
- Characteristics of DC motors.
- Hysteresis and Eddy current loss
- Difference between power and distribution transformers
- Industrial Applications of DC generators
- Safety to be followed while using special transformers

2. **Survey** –
   - Carry out a market survey for availability of transformers in market and list down the complete specifications of at least five transformers.
   - Carry out a market survey for availability of DC generators in market and list down the complete specifications of at least five DC generators.
   - Carry out a market survey for availability of DC motors in market and list down the complete specifications of at least five DC motors.
   - Carry out internet survey to find out the types of insulation used between HV and LV winding and between winding and core for a HV, EHV and UHV transformer

3. **Visits**- Visit nearby substation and collect the name -plate specifications of sub-station transformers.

d. Self-Learning Topics:

1. Types of motors used in Metro, Mono rail and traction
2. Soft starters
3. Dry transformers.
4. Energy efficient DC Motors.
5. Insulation material used for HV and LV winding of transformers.
6. Industrial/commercial applications of special transformers
7. Advances in Transformers- Amorphous Metal Transformer

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 the 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%	20%	20%	30%	30%	20%	20%
CO-2	20%	25%	20%	30%	20%	25%	20%
CO-3	25%	20%	20%	20%	20%	25%	20%
CO-4	25%	20%	20%	20%	30%	15%	20%
CO-5	15%	15%	20%	-	--	15%	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 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: 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 DC Generators	8	CO1	14	4	3	5
Unit-2.0 DC Motors	12	CO2	16	4	2	4
Unit-3.0 Single Phase Transformer	10	CO3	14	5	5	9
Unit-4.0 Three Phase Transformer	10	CO4	14	2	3	5
Unit- 5.0 Special purpose Transformers	8	CO5	12	5	5	9
Total Marks	**48**	**-**	**70**	**20**	**18**	**32**

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.	Identification of parts of a DC Machine by dismantling the cut section model of a DC machine	CO1	50	40	10
2.	Effect of speed and field flux on generated voltage of DC shunt generator	CO1	50	40	10
3.	Load test of DC shunt Generator	CO1	50	40	10
4.	Load test of DC series Generator	CO1	50	40	10
5.	Starting of D. C shunt motor using 3-point /4-point starter	CO2	50	40	10
6.	Reversal of direction of a DC Shunt motor	CO2	50	40	10
7.	Speed control of D.C shunt motor	CO2	50	40	10
8.	Speed control of a DC Shunt motor	CO2	50	40	10
9.	Load test of D. C shunt motor	CO2	50	40	10
10.	Load test of D.C. series motor	CO2	50	40	10
11.	Brake test of D.C. shunt motor.	CO2	50	40	10
12.	Measurement of voltage and current ratio of a given single phase transformer.	CO3	50	40	10
13.	Polarity of a single-phase transformer	CO3	50	40	10
14.	Direct load test on a single-phase transformer	CO3	50	40	10
15.	No load waveform of a transformer using CRO	CO3	50	40	10
16.	Open Circuit and Short Circuit test on a single-phase transformer.	CO3	50	40	10
17.	Perform Parallel operation of two single phase transformers.	CO3	50	40	10
18.	Auto transformer and 1-phase two winding transformer of same rating	CO3	50	40	10
19.	Parallel operation of two three phase transformers for equal and unequal load sharing	CO4	50	40	10
20.	Current ratio of a Current transformer	CO5	50	40	10
21.	Voltage ratio of a Potential Transformer	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 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, 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.	DC Ammeter	Range (0-5-10A), (0-2 A), Portable analog, PMMC type as per relevant BIS standard	2-4,6-11
2.	DC Voltmeter	Range (0-150/300V), (0-15/30/75 V), Portable analog PMMC type as per relevant BIS standard	1-11
3.	AC Ammeter	Range (0-2.5-5-10A), Portable analog MI type as per relevant BIS standard	12-20
4.	AC Voltmeter	Range (0-75/150/300V), Portable analog MI type as per relevant BIS standard	12-21
5.	Lamp Load	10 -20 A	As applicable
6.	Rheostat	0-500 Ohm, 1.2A); (0-100 Ohm, 5A); (0- 50 Ohm, 10A); (0-350 Ohm,1.5A); Nichrome wire wound rheostat on epoxy resin or class F insulating tube with two fixed and one sliding contact	As applicable
7.	DC Supply	230V DC, 50A supply (with inbuilt rectifier to convert AC to DC)	2-11
8.	Single phase transformer	Of suitable rating (500 VA to 2kVA)	12-18
9.	Single phase auto transformer	230V/0-270 V, 4/8/15 A	12-19
10.	Wattmeter (LPF and UPF) Single phase 3 phase	0-150/300/600V, 2.5/5 A 0-300/600 V, 10/20 A	12-19
11	DC Series Motor - Gen Set	Motor – 5 HP, Generator- 3 kW	4,10
12.	DC Shunt Motor - Gen Set	Motor – 5 HP, Generator- 3 kW	2,3,9,10
13.	DC motor Starter	3 Point/4 Point starter	5
14.	Current Transformer	Appropriate rating	20
15.	Potential Transformer	Appropriate rating	21
16.	Tachometer	Digital	2-11
17	Three phase transformers	Experimental setup/software for performing 3 phase transformer parallel operation	19

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author (s)	Publisher and Edition with ISBN
1.	Electrical Machines	Kothari, D.P. & Nagrath, I.J.	Tata McGraw Hill Education Pvt. Ltd. New Delhi, 4th Edition,ISBN: 9780070699670
2.	Electric Machines	Ashfaq Husain	Dhanpat Rai & Company, Latest Edition, ISBN: 6700000000432
3.	Electrical Technology, Volume – II (AC & DC Machines)	Theraja B.L.	S. Chand and Co. Ltd., New Delhi , Latest Edition, ISBN:9788121924375
4.	Electrical Machinery	Dr. P.S. Bhimbra	Khanna Publications, Latest Edition ISBN: 8174091734
5.	Basic Electrical Engineering (Hindi)	Mehta & Gupta	Dhanpat Rai Publishing Company(P) Ltd., 9th Edition, 2013, ISBN: 978938437826
6.	Electrical Machines	Bhattacharya S. K.	Tata McGraw Hill Education Pvt. Ltd., New Delhi ISBN:9789332902855
7.	Electrical Machines (AC & DC)	Gupta J. B.	S. K. Kataria & Sons, New Delhi, ISBN:9788188458141
8.	Electrical Machines	Kothari, D.P. & Nagrath, I.J.	Tata McGraw Hill Education Pvt. Ltd. New Delhi, SBN:9780070699670
9.	Basic Electrical Engineering	Mittle V.N. and Mittal Arvind	Tata McGraw Hill Education Pvt. Ltd. New Delhi, ISBN:9780070593572
10.	Electric Machinery	Arthur Eugene Fitzgerald and Charles Kingsley	Tata McGraw Hill Education Publications ISBN13: 9780070530393
11.	Electrical Engineering Fundamentals	Vincent Del Toro	Prentice hall Publications ISBN-13 :9780132475525

(b) Online Educational Resources:

1) www.nptel.com/iitm/
2) www.vlab.com/
3) Electrical Machines: - http://www.eeeuniversity.com/2013/07/animation-of-electric-machines.html
4) Transformer: -https://www.youtube.com/watch?v=vh_aCAHThTQ
5) AC /DC Motor and Generator: -https://www.youtube.com/watch?v=4texz0Gn7cw
6) DC Motor & Generator: -https://www.youtube.com/watch?v=LAtPHANEfQo
7) AC DC motors: https://www.youtube.com/watch?v=unxTKC01CBQ

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. Learning Packages related to D. C. Machines and Transformers
2. Users' Guide for D.C. Machines and Transformers
3. Manufacturers' Manual for D.C. Machines and Transformers
4. Lab Manuals for D.C. Machines and Transformers

******

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.
- 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 theses 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: 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 system. *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 + $\overline{A}$C + B$\overline{C}$ 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 digits 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 educational recourses 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 / easy EDA/ circuitlab & like.

******

A) CourseCode : 2474305

B) CourseTitle **:** EDA Tools & MATLAB Applications

C) Pre-requisiteCourse(s) **:** Basic Electronics

D) Rationale **:**

EDA Tools & MATLAB Applications is used widely to design equipment so that the final product will be as close as possibleto design specifications without expensive in process modification. 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) CourseOutcomes(COs): After thecompletion of th ecourse, 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: Perform various arithmetic operations and plot different types of plots using MATLAB.

CO-5: Interpret the simulated model of electrical/electronic circuits developed using Simulink.

F) SuggestedCourseArticulationMatrix(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 Practicesfor Society, Sustainabilityand 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 Nomapping (-)

***** 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&LearningScheme:

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				
	EDA Tools & MATLAB Applications	-	-	04	02	06	03

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, fieldorother 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, microprojects, industrial visits, anyother student activities etc.)

SL: SelfLearning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits=(1xCIhours) +(0.5xLIhours) +(0.5xNotionalhours)

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) AssessmentScheme:

CourseCode	CourseTitle	AssessmentScheme(Marks)						TotalMarks(TA+TWA+LA)
		Theory Assessment(TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment(LA)		
		Progressive TheoryAssessment (PTA)	End TheoryAssessment (ETA)	Internal	External	Progressive LabAssessment (PLA)	End LaboratoryAssessment(ELA)	
	EDA Tools & MATLAB Applications	-	-	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: Termwork & SelfLearning Assessment (Includes assessment related to student performance in assignments, seminars, micro-projects, industrial visits, self-learning, any other student activities, etc.)

Note:

- ETA&ELAaretobecarriedout attheendoftheterm/semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** aswell as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, andseminar 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 ofinternal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, theinternal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level andsession 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 TheorySession 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 beintegratedappropriately.

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. *TSO1b.*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. *TSO1f.* Use EDA/simulation tool to create new file.	**Unit-1.0 Introduction to EDA/SimulationTool** 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**
TSO2a. Construct the clipper and clamper circuits. *TSO2b* .Construct the half wave and full wave rectifier circuits. *TSO 2c.* Compare different configuration of BJT as an amplifier using simulation results. *TSO2d.* Construct different types of passive filters. *TSO2e* .Compare the characteristics of thyristor devices like SCR, DIAC, and TRIAC using simulation result.	**Unit-2.0 Analog Circuits Simulation** 2.1 Clipper&Clampercircuits 2.2 Rectifiers: • Half-waveRectifiers • CentreTapped full wave Rectifier • Full wave Bridge Rectifier 2.3 BJTAmplifiers: • CEAmplifier • CBAmplifier • CCAmplifier 2.4 PassiveFilters: • LowPassFilter • HighPassFilter • BandstopFilter • BandpassFilter 2.5 SCR,DIAC,TRIAC	**CO2,CO1**
TSO 3a. Construct the circuit diagram of half adder/subtractor using basic gates. *TSO3b.* Construct the circuit diagram of full adder/subtractor using universal gates. *TSO3c.* Construct circuit diagram of Full adder/subtractor using half adder/subtractor. *TSO 3d.* Construct the circuit diagram of multiplexer/demultiplexer. *TSO3e.* Construct the circuit diagram of different types of flip-flops.	**Unit-3.0 Digital Circuits Simulation** 3.1 LogicGates 3.2 HalfAdder/Subtractor 3.3 FullAdder/Subtractor 3.4 Multiplexer and Demultiplexer 3.5 Flipflops • R-S FlipFlop • J-K FlipFlop • D and T Flipflop 3.6 ADC, DAC 3.7 Data acquisition system	**CO3,CO1**

Major Theory Session Outcomes(TSOs)	Units	Relevant COs Number(s)
TSO3f .Describe working of ADC and DAC. *TSO 3g* .Identify the different blocks of Data acquisition system.		
TSO 4a. List the major components of MATLAB environment. *TSO 4b.* Explain with an example the basic arithmetic operation on matrices and Arrays. *TSO 4c.* Perform functions and operations using variables and arrays to learn about relational and logical operators. *TSO 4d.* Access different features such as creating M-File, save M-File of MATLAB. *TSO 4e.* Perform basic operation on matrices such as addition, subtraction, multiplication with simple examples *TSO 4f.* Use functions in MATLAB in different applications of mathematical operation. *TSO 4g.* Describe the procedural steps to plot various graphs as per given condition.	**Unit-4.0 MATLAB Environment** 4.1 Introduction: Features, applications, and software versions 4.2 Getting started MATLAB: Using it as a calculator, creating variables, overwriting variables, Error messages, and Making corrections 4.3 M-File Script; Examples, Script side-effects M-File Functions; Anatomy of a M-File function, Input and output arguments, 4.4 Controlling the hierarchy of operations or precedence, Controlling the appearance of floating-point numbers, 4.5 Managing the Workspace 4.6 Matrices and Operators: Introduction, the Colon Operator, Accessing Parts of a Matrix, Combining and Transforming Matrices, Matrix Building, Input-output, Plotting, Debugging. 4.7 Functions: Introduction, Function I/O, Formal Definition of Functions, Subfunctions, Scope, Advantages of Functions, Scripts, and Problem Solving 4.8 Plotting: Creating simple plots, adding titles, axis labels, and annotations, Multiple data sets in one plot, specifying line styles and colors, Copy/Paste Figures, Saving Figures	**CO4,CO1**
TSO 5.a Use Simulink to plot the transient analysis of RLC, RL and RC circuits for sinusoidal and step inputs. TSO 5.b Use Simulink to verify Superposition theorem, Thevenin's theorem, Norton's theorem and Maximum Power Transfer theorem, analyze and interpret the results TSO 5.c Use Simulink to plot the various performance characteristics of for 3-phase Induction motor. TSO 5.d Use Simulink to plot pole zero pattern for a given Transfer Function. TSO 5.e Use Simulink to plot the various waveforms for power converters. TSO 5.f Use Simulink to perform fault analysis for a given power system network.	**Unit-5.0 Simulink** 5.1 Getting Started with Simulink 5.2 Simulink Library Browser 5.3 Connections 5.4 Block Specification 5.5 Toolboxes 5.6 Building Systems 5.7 Circuit Simulation using Simulink: • Electrical Circuits and networks • Electrical Machine • Power system • Control system and • Power Electronics	**CO5**

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

K) SuggestedLaboratory(Practical)SessionOutcomes(LSOs)and List of Practical: P2421305

Practical/Lab Session Outcomes(LSOs)	S.No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO1.1. Install EDA software. *LSO1.2.*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
LSO3.1. Simulate the clamper circuits. *LSO3.2.*Analyze the output wave form for clamper circuit.	3.	Test the functionalities of clamper circuits using appropriate EDA/simulation tool.	CO2,CO1
LSO4.1. Simulate the half wave rectifier circuit. *LSO4.2.* 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 fullwave rectifier circuit. *LSO5.2.* Analyze the output wave form for Center tapped fullwave rectifier circuit.	5.	Test the functionalities of center tapped fullwave rectifier circuit using appropriate EDA & simulation tool.	CO2,CO1
LSO6.1. Simulate the schematic diagram of bridge full waverectifier circuit. *LSO6.2.* Analyze the output waveform for bridge fullwave rectifier circuit.	6.	Test the functionalities of bridge full wave rectifier circuit using appropriate EDA /simulation tool.	CO2,CO1
LSO7.1. Simulate the filter circuit on EDA tool. *LSO7.2.* Analyze the output wave form for Various passive filter circuits.	7.	Test the functionalities of passive filter circuits using appropriate EDA/simulation tool.	CO2,CO1
LSO8.1. Simulate the circuit of SCR using EDA tool. *LSO8.2.*Analyze the output wave form of SCR.	8.	Test the VI characteristics of SCR.	CO2,CO1
LSO9.1. Simulate the circuit of DIAC using EDA tool. *LSO9.2.*Analyze the output wave form of DIAC.	9.	Test the VI characteristics of DIAC.	CO2,CO1
LSO10.1. Simulate the circuit of TRIAC using EDA tool. *LSO10.2.*Plot VI characteristics of TRIAC.	10.	Test the VI characteristics of TRIAC.	CO2,CO1
LSO11.1. Realize the given Boolean expression using logic gates. *LSO11.2.* Verify its truth table by EDA/simulation tool.	11.	Verify the truth table of different logic gates using appropriate EDA/simulation tool.	CO3,CO1
LSO12.1. Draw the schematic diagram of adder /subtractor. *LSO12.2.* Verify its truth table by EDA/ simulation tool.	12.	Test the functionalities of adder/subtractor using appropriate EDA/simulation tool.	CO3,CO1

Practical/LabSessionOutcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO13.1. Draw the logic diagram of multiplexer/demultiplexer. *LSO13.2.*Verify its truth table by EDA/simulation tool.	13.	Simulation of multiplexer,demultiplexer using appropriate EDA/simulation tool.	CO3,CO1
LSO14.1. Draw the logic diagram of R-S/J-K/D/T flip-flops. *LSO14.2.*Observe the output waveform.	14.	Simulation of R-S/J-K/D/Tflip-flops using appropriate EDA/simulation tool.	CO3,CO1
LSO15.1. Draw the logic diagram of Modulo-N ripple/synchronous counters. *LSO15.2.*Observe the output waveform of Modulo-N ripple/synchronous counters.	15.	Simulation of Modulo-Nripple/synchronous counters using appropriate EDA/simulation tool.	CO3,CO1
LSO16.1. Design R-2R resistive network circuit. *LSO16.2.*Verify DAC output.	16.	Simulation of R-2R resistive network DAC using appropriate simulation tools.	CO3,CO1
LSO 17.1. Write a MATLAB program toperform basic operations on matrices such as addition, subtraction, multiplication.	17.	Basic operation on matrices, such as addition, subtraction, multiplication using MATLAB	CO4
LSO 18.1. Write a MATLAB program for generation of various signals such as unit impulse, unit step, square, saw tooth, triangular, sinusoidal, ramp etc.	18.	MATLAB program to generate various signals such as Unit impulse, unit step, square, saw tooth, triangular, sinusoidal, ramp etc.	CO4
LSO 19.1. Write a MATLAB program for Perform functions and operations using variables and arrays to learn about relational and logical operators.	19.	MATLAB program for Perform functions and operations using variables and arrays to learn about relational and logical operators.	CO4
LSO 20.1. Write a MATLAB program for the operations on signals and sequences such as addition, multiplication, scaling, shifting, and folding.	20.	MATLAB program for operations on signals and sequences such as addition, multiplication, scaling, shifting, folding.	CO4
LSO 21.1. Write MATLAB program to perform functions and operations using variables and arrays to learn about trigonometric and exponential manipulations.	21.	MATLAB program to perform functions and operations using variables and arrays to learn about trigonometric and exponential manipulations.	CO4
LSO 22.1. Write MATLAB program to plot and label 2-dimensional functions like Sin (t), Cos(t), Tan(t) and Sec(t) etc., for a given duration.	22.	MATLAB program for plotting and labelling 2-dimensional functions like Sin(t), Cos(t), Tan(t) and Sec(t) etc., for a given duration.	CO4
*LSO23.1.*Simulate a series and parallel resonant circuit.	23.	Simulation of Series and Parallel resonant circuit using Simulink.	CO5
LSO 24.1. Plot various waveforms of half wave rectifier from simulated model.	24.	Simulation of Half Wave rectifier using Simulink.	CO5
LSO 25.1. Plot various waveforms of single-phase diode bridge rectifiers with filter for R and RL loads from simulated model.	25.	Simulation of single-phase diode bridge rectifiers with filter for R and RL loads using Simulink.	CO5
LSO 26.1. Plot various waveforms of a full wave-controlled rectifier from simulated model.	26.	Simulation of a full wave-controlled rectifier using Simulink.	CO5

LSO 27.1. Plot various waveforms of a bridge-controlled rectifier from simulated model.	27.	Simulation of Bridge Controlled Rectifier using Simulink.	CO5

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

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

b. MicroProjects:

i. Design, simulate and build circuit for D.C. motor to rotate in clockwise and anticlockwise direction using transistor.
ii. Design, simulate and build on general purpose PCB to test circuit using opto-coupler for turn ON/OFF fan/light.
iii. Simulate and build circuit using diodes and resistors to display numerals from 0 to 9 on seven segment display.
iv. Design, simulate and build circuit to count 10 objects (pulses) for five times.
v. Simulate and build digital codelock 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.
vi. Design, simulate and build circuit for water level controller using logic gates.
vii. Design and simulate simple emergency light system using any EDA tool.
viii. Design and simulate pressure measurement system using appropriate EDA tool.
ix. Design and simulate temperature measurement system using appropriate EDA tool.

c. OtherActivities:

1. SeminarTopics:

- Various device design process using simulation tool.
- Various process involved in circuit design process.
- Functions of Simscape components of MATLAB.

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
- Fault analysis of IEEE 9 bus system in MATLAB

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 SemTest	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.

Suggested Specification Table for End Semester Theory Assessment: (NotApplicable)

N) 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 halfwave rectifier circuit using appropriate EDA/simulation tool.	CO2,CO1	30	60	10
5.	Test the functionalities of center tapped fullwave rectifier circuit using appropriate EDA/simulation tool.	CO2,CO1	30	60	10
6.	Test the functionalities of bridge fullwave 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 appropriatesimulation tools.	CO3,CO1	30	60	10
17.	Basic operation on matrices, such as addition, subtraction, multiplication using MATLAB	CO4	30	60	10
18.	MATLAB program to generate various signals such as Unit impulse, unit step, square, saw tooth, triangular, sinusoidal, ramp etc.	CO4	30	60	10
19.	MATLAB program for Perform functions and operations using variables and arrays to learn about relational and logical operators.	CO4	30	60	10
20.	MATLAB program for operations on signals and sequences such as addition, multiplication, scaling, shifting, folding.	CO4	30	60	10
21.	MATLAB program to perform functions and operations using variables and arrays to learn about trigonometric and exponential manipulations.	CO4	30	60	10
22.	MATLAB program for plotting and labelling 2-dimensional functions like Sin(t), Cos(t), Tan(t) and Sec(t) etc., for a given duration.	CO5	40	50	10
23.	Simulation of Series and Parallel resonant circuit using Simulink.	CO5	40	50	10
24.	Simulation of Half Wave rectifier using Simulink.	CO5	40	50	10
25.	Simulation of single-phase diode bridge rectifiers with filter for R and RL loads using Simulink.	CO5	40	50	10
26.	Simulation of a full wave-controlled rectifier using Simulink.	CO5	40	50	10
27.	Simulation of Bridge Controlled Rectifier using Simulink.	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.

O) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies maybe 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.

P) 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/Or CAD/ Multi Sim/SPICE/Easy EDA/Circuit Logix/Micro Cap/Sci lab	All
2.	Personal Computer	8GB RAM,500GB HDD,i7 or higher processor	All
3.	MATLAB along with Electrical related tool boxes	Latest license	17-21
4.	Simulink	Simulink should be enabled in MATLAB license	22-27

Q) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	EssentialElectronicDesignAutomation	Mark D.Birnbaum,	PrenticeHall,Fourthedition,2004ISBN: 978-0131828290
2.	Programming in Scilab4.1	VinuV.Das	New Age Publication, New Delhi,2014, ISBN:978-8122424713
3.	Modeling and simulation using MATLAB	Shailendra Jain	Wiley India Pvt. Ltd., New Delhi,2014, ISBN:978-8126551972
4.	Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers	Rudra Pratap	Oxford; Seventh Edition, 2019, ISBN:978-0190091972
5.	Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers	Rudra Pratap	Seventh edition, 2019, Oxford HED ISBN: 9780190091972
6.	MATLAB and Simulink for Engineers	Agam Kumar Tyagi	First edition 2011, Oxford University Press, India ISBN: 9780198072447, 9780198072447
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	McGrawHillEducation,NewDelhi,2010. ISBN:978-0070144781
9.	Electrical & Electronics Measurement	A.H.Sawhney	DhanpatRaiandSons,NewDelhi,2012,ISBN:978-817001006
10.	Modern Digital Electronics	R.P.Jain	McGrawHillEducation,NewDelhi,2009, ISBN: 978-0070669116

(b) OnlineEducationalResources:

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
18. https://in.mathworks.com/help/matlab/
19. https://in.mathworks.com/help/simulink/

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

(c) Others:

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

******

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 ofCourse Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 relatedreforms 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: T2400308 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).

******

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

****