Curriculum of Diploma Programme

in

Electrical Engineering

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

**State Board of Technical Education
(SBTE), Bihar**

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				
2420301	Electrical Circuit and Networks	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)	
2420301	Electrical Circuit and Networks	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 (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: T2420301

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Classify the given components into active and passive. TSO 1b. Differentiate between the following: • Linear and nonlinear, • Unilateral and bilateral, • Lumped and distributed parameters, • Independent and dependent source TSO 1c. Describe the nature of the voltage-current characteristics of the given type of voltage source TSO 1d. Reduce the given passive network by using star-delta transformation TSO 1e. Determine the equivalent resistance by using star/delta transformation from voltage to current transformation and vice versa. TSO 1f. Apply Kirchhoff's Current and Voltage Law to analyze the given electric circuit(s). TSO 1g. Apply mesh analysis and nodal analysis to determine the ccurrent and voltage in a given circuit. TSO 1h. Explain Transient and steady state condition in a given circuit TSO 1i. Determine initial state and steady state of R, L & C in DC Circuit and give its application	**Unit-1.0 Basics of Electrical Circuits** 1.1 Definition of: • Linear and non-linear • Active and passive components • Unilateral and bilateral • Lumped and distributed parameters • Independent and dependent source 1.2 Concept of open circuit, closed circuit and short circuit, node, branch, mesh and loop 1.3 Star/Delta transformation of passive network 1.4 Source transformation 1.5 Kirchoff's Current Law (KCL) and Kirchoff's Voltage Law (KVL), Applications 1.6 Mesh Analysis and Nodal analysis of networks 1.7 Transient & steady state 1.8 Concept of initial and final conditions in switching circuits, Meaning of t =o-, t =o+, and t = infinite. R, L and C at initial and final conditions	CO1
TSO 2a. Solve a given complex linear active bilateral electrical circuit/network with multiple source using superposition theorem. TSO 2b. Substitute a given complex electrical circuit/network across its load terminals by a equivalent circuit comprising of a voltage source in series with Thevenin's resistance. TSO 2c. Simplify a given linear complex electrical circuit/network to an equivalent circuit comprising of current source in parallel with resistance. TSO 2d. Transfer supply voltage and output current mutually in a linear passive electrical circuit/network by applying reciprocity theorem and also mention its applications TSO 2e. Determine the conditions for maximum power transfer across Load	**Unit-2.0 Network Theorems:** 2.1 Superposition theorem and its applications 2.2 Thevenin's theorem and its applications 2.3 Norton's theorem and its applications 2.4 Reciprocity theorem and its applications 2.5 Maximum power transfer theorem 2.6 Application of theorems to solve DC networks	CO1, CO2
TSO 3a. Explain the behavior of AC voltage, current and power through pure resistance, pure inductance and pure capacitance with sketches	**Unit-3.0 Single Phase AC Circuits:** 3.1 Generation of an alternating EMF	CO3

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3b. Determine the current and voltage, impedance of thegiven series/parallel RL/RC/LC/ RLC circuit TSO 3c. Determine the active, reactive, apparent power and power factorof the given AC circuit Differentiate the given AC circuit quantities. TSO 3d. Represent the given AC circuit quantities in complex form. TSO 3e. Convert the given AC quantity in rectangular to polar and vice versa and other arithmetic operations. TSO 3f. Determine the current and voltage, impedance of the given series/parallel RL/RC/ RLC circuit TSO 3g. Determine the active, reactive, apparent power and power factor of the given AC circuit	3.2 AC circuit quantities: Peak value, RMS and Average value of a Sinusoidal voltage waveform 3.3 Vector representation of an alternating quantity, addition, subtraction, multiplication and division, Conversion from rectangular to polar and vice versa and exponential form 3.4 Waveforms, phasor diagram and expression of voltage, current and power in pure: Resistance, Inductance, Capacitance 3.5 AC Series and parallel circuits, Phasor diagrams and impedance triangle 3.6 Active, reactive, apparent power with examples, Power factor, lagging, leading and unity power factor, effects of poor power factor, power triangle	
TSO 4a. Explain the phenomena of resonance in the given RLC series and parallel circuit with sketches TSO 4b. Determine the resonant frequency of the given series RLC circuit TSO 4c. Explain the significance of quality factor of the given series RLCcircuit. TSO 4d. Determine the equivalent impedance and current magnitude ofthe given parallel RLCcircuit under resonance condition TSO 4e. Explain 2-port network and classify it. TSO 4f. Determine the Z, Y & T parameter using electrical circuits TSO 4g. Determine the conditions of symmetricity and reciprocity of two port networks	**Unit-4.0 Resonance and Two Port Network:** 4.1 Resonance and itsimportance in electrical circuit 4.2 Series & Parallel resonance: Resonant frequency, Quality factor, bandwidth and selectivity in series & Parallel RLC circuit. 4.3 Magnification in series and parallel resonant circuit 4.4 Comparison of series and parallel resonance and its applications 4.5 Significance of two port network and its types 4.6 Open Circuit (Z) parameter, Short Circuit (Y) parameter & Transmission parameter 4.7 T and Pie representation of circuits Symmetry and reciprocity of two port network	CO3, CO4
TSO 5a. Explain phase and time displacement of three phases. TSO.5.b Determine the current drawn by the given three phase balanced load connected in star/delta. TSO.5.c Explain the line and phase relation of current /voltage of three phase circuit. TSO.5.d Determine the current drawn by the given three phase loads connected in parallel. TSO.5.e Determine the power and power factor of the given three phase load using two wattmeters TSO.5.f Determine the power factor of the given type of three phase load connected in parallel using power triangle.	**Unit-5.0 Three phase AC circuits** 5.1 Generation of threephase voltage 5.2 Three phase three wire source and three phase four wire source, Phase sequence and phasor diagram 5.3 Line and phase relationship: Star/Delta 5.4 Three phase load -balanced and unbalanced Load 5.5 Measurement of power in three phase circuits	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: P2420301

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1.	Identify the commonly used components in an electrical circuit.	1.	Identification of components used in the given electrical Circuit	CO1
LSO 1.2.	Measure voltage and current using suitable meters/instruments in the given linear electric circuit.	2.	Measurement of voltage and current in a given linear electrical circuit.	CO1
LSO 1.3.	Measure current and voltage in a given electric circuit by applying Kirchhoff 's Current law.	3.	Measurement of current and voltage in a branch of the given electrical circuit using Kirchhoff's Current Law.	CO1
LSO 1.4.	Measure voltage drop in a closed loop in a given electric circuit by applying Kirchoff's Voltage Law.	4.	Measurement voltage drop in closed loop of the given electrical circuit using Kirchhoff's Voltage Law.	CO1
LSO 1.5.	Connect star connected resistances to its equivalent delta connection and determine the equivalent resistance.	5.	Connection of star connected resistances to its equivalent delta connection to measure the equivalent resistance.	CO1
LSO 1.6.	Connect delta connected resistances to its equivalent Star connection and determine the equivalent resistance.	6.	Connection of delta connected resistances to its equivalent Star connection to measure the equivalent resistance.	CO1
LSO 1.7.	Measure current and voltage of the given electric circuit using mesh analysis technique.	7.	Application of mesh analysis to measure current and voltage of the given electric circuit.	CO1
LSO 1.8.	Measure voltage across a circuit element of a given electric circuit applying nodal analysis technique.	8.	Application of nodal analysis to measure voltage across a circuit element of a given electric circuit	CO1
LSO 2.1.	Measure current in a branch of the given bilateral multiple source circuit using superposition theorem.	9.	Measurement of current in a branch of the given electrical circuit having two or more input sources using Super position theorem.	CO1, CO2
LSO 2.2.	Determine the circuit parameters of the given network using Thevenin's theorem.	10.	Measurement of load current in the load resistance using Thevenin's theorem in a given circuit.	CO1, CO2
LSO 2.3.	Determine the circuit parameters of the given network using Norton's theorem.	11.	Measurement of load current in the load resistance using Norton's theorem in a given circuit.	CO1, CO2
LSO 2.4.	Measure the value of load resistance for which maximum power is produced in the given electric circuit.	12.	Measurement of the value of load resistance for which maximum power is produced in a given electric circuit.	CO1, CO2
LSO 3.1.	Measure the peak value, RMS value, Period and frequency of a sinusoidal voltage using CRO.	13.	Measurement of peak value, RMS value, Period and frequency of a sinusoidal voltage using CRO.	CO2, C03
LSO 3.2.	Plot the waveform of voltage and current in a resistive load using CRO.	14.	Waveform of voltage and current in a resistive load.	CO2, C03
LSO 3.3.	Plot the waveform of voltage and current in an R-L load.	15.	Plot the waveform of voltage and current in a R-L load.	CO2, C03
LSO 3.4.	Plot the waveform of voltage and current in an R-L-C load.	16.	Plot the waveform of voltage and current in a R-L-C load	CO2, C03
LSO 3.5.	Measure the voltage, current in a series RLC circuit and calculate power and power factor and draw phasor diagram.	17.	Measurement of voltage, current, power and power factor in a series RLC circuit	CO2, C03

A)	**Course Code**	: **2420302(T2420302/P2420302/S2420302)**
B)	**Course Title**	: Electrical Measurement and Instrumentation
C)	**Pre- requisite Course(s)**	: Basic Mechanical Engineering, Basic Electrical Engineering
D)	**Rationale**	:

The electrical engineering diploma engineers are expected to measure precisely voltage, current, power, energy, etc. by using different types of meters. Therefore, they should be competent to use, calibrate and maintain different types of electrical and electronics measuring instruments used in the industry and electrical systems. This course being the core course, demands a better understanding of the construction, materials used and principle of operation safe operating procedures of various types of measuring instruments. The students after passing this course should possess the knowledge, skill set not only to use appropriate measuring instruments correctly and precisely but also should be able to maintain the same.

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

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

CO-1   Interpret the basic concepts of measurement   and instrumentation for measuring instruments.
CO-2   Measure current and voltage in an electrical system.
CO-3   Measure power and energy in single and three phase systems.
CO-4   Measure resistance, inductance, and capacitance using bridges/meters.
CO-5   Use various instruments/meters for measuring electrical parameters such as power factor, Phase sequence, and circuit components.

F)   **Suggested Course Articulation Matrix (CAM):**

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

J) Theory Session Outcomes (TSOs) and Units: T2420302

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1.a Explain basic concept and significance of measurements. TSO.1.b Differentiate between deflecting, controlling and damping torque in an instrument. TSO.1.c Explain the given terms related to measuring systems. TSO.1.d Classify types of errors in measurement. TSO.1.e Classify different types of instruments.	**Unit-1.0 Basics of Measurement and Instrumentation** • Measuring systems and requirements: Block diagram • Deflecting, controlling and damping torque • Accuracy, precision, Resolution, tolerance, sensitivity and repeatability • Errors in measurement • Types of errors- Limiting error, Gross error, systematic Error, Random Error, Guaranteed accuracy error • Classification of basic instruments -Indicating, Recording and Integrating type	**CO1**

TSO.2.a Explain the general principle of measuring current, voltage in an electrical system.
TSO.2.b Extend the range of ammeter and voltmeter using shunt, multipliers and Current Transformer and Potential Transformer
TSO.2.c Describe the calibration procedure of the given meters.
TSO.2.d Describe the construction and working principle of the given types of electromechanical measuring instruments.
TSO.2.e Explain the working principle of the given types of electromechanical measuring instruments.
TSO.2.f Explain the significance of using electronic instruments
TSO.2.g Explain the working of true rms voltmeter with block diagram.
TSO.2.h Explain the working of DVM with block diagram.
TSO.2.i Describe working and advantage of digital multi meter with block diagram.
	Unit-2.0 Measurement of Voltage and Current
	
	• Current and voltage measurement: Principle
	• Galvanometer, Ammeter, Voltmeter
	• Calibration of ammeter and voltmeter
	• Range Extension of ammeter and voltmeter using:
	  - Shunts and Multipliers
	  - Current Transformer (CT) and Potential Transformer (PT)
	  (Construction, working and applications)
	• Permanent Magnet Moving Coil (PMMC), Moving iron, Induction, Dynamometers type instruments: Working principle, construction, applications, merits and demerits
	• Essentials and advantages of electronic instruments
	• True RMS reading voltmeter.
	• Digital Voltmeters (DVM) and its types
	• Digital multimeters- Block diagram
		CO2

TSO.3.a Explain the general principle of measuring power and energy in an electrical system TSO.3.b Explain the working of induction and dynamometer type instruments. TSO.3.c Explain the general principle of measuring single and three phase power in an electrical system TSO.3.d Apply the power measuring technique in distribution and transmission system. TSO.3.e Describe the construction and working of single and 3 phase energy meters TSO.3.f Determine errors and compensation in an energy meter.	**Unit-3.0 -Measurement of Power and Energy** • Power and energy Measurement: Principle • Measurement of single and three phase power using wattmeter - one wattmeter and two wattmeter method • Effect of power factor variation on wattmeter reading in two wattmeter method • Measurement of energy using single phase and three phase watt-hour/Energy meter • Errors and compensation in energy meter • Cripping and phantom loading in energy meter • Calibration of watt meters and energy meters • Digital energy meter: Block diagram, Working	**CO3**

Major Theory Session Outcomes (TSOs)		Units	Relevant COs Number(s)
TSO.3.g	Describe the standard procedure for calibration of the given equipment.		
TSO.4.a	Classify the resistance into low, medium and high.	**Unit 4.0-Measurement using Bridges/Meters**	**CO4**
TSO.4.b	Explain the basic concept of bridge and bridge balancing.	• Classification of resistances - Low, Medium and High	
TSO.4.c	Describe the procedure to measure unknown resistance (low, medium and high) using appropriate bridge/method.	• Concept of bridge, balancing • Resistance measurement -Kelvins double bridge (Low), voltmeter - ammeter method, Wheatstone bridge, ohmmeter (Medium) and Megger (High).	
TSO.4.d	Describe the method of using Earth tester to measure earth resistance	• Earth resistance	
TSO.4.e	Describe the procedure to measure an unknown inductance by using appropriate bridge	• Inductance measurement – Anderson, Maxwell inductance capacitance bridge	
TSO.4.f	Describe the procedure to measure the unknown Capacitance using appropriate bridge	• Capacitance Measurement- Schering bridge. • Frequency Measurement -Wein Bridge, Weston Frequency meter.	
TSO.4.g	Describe the procedure to measure an unknown frequency by using Wein Bridge/ Weston Frequency meter.		
TSO.5.a	Describe the procedure to measure the power factor by using P.F meter.	**Unit 5.0– Measurement of Other Electrical Parameters**	**CO5**
TSO.5.b	Describe the procedure of using a Phase sequence indicator to determine the phase sequence	• Dynamometer, Power Factor meter • Phase sequence indicator: rotating type • Synchro scope	
TSO.5.c	Explain the use of Synchroscope in synchronization	• CRO-basic clock diagram, Cathode Ray Tube, Electrostatic and magnetic deflection, X & Y Amplifiers, Controls on CRO and their functions, Lissajous pattern	
TSO.5.d	Describe functions of basic building blocks of CRO	Measurement of voltage, amplitude, time period, frequency and phase angle	
TSO.5.e	Explain deflection systems of CRO		
TSO.5.f	Explain working of digital storage oscilloscope using block diagram.	• Digital Storage Oscilloscope- Basic block diagram and working	
TSO.5.g	Describe the working of Q/ LCR meter using block diagram	• Q/LCR meter, Digital LCR meter- Block diagram, Working principle	
TSO.5.h	Explain the working of the given type of recorders with the help of a block diagram	• Analog/Digital recorders, Graphic recorder, Strip Chart recorder, XY recorder (Only block diagram) • Applications of Recorders.	

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

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

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.	**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)
TSO.3.k	Differentiate between autotransformer and two winding transformers.	3.14 Energy efficient Amorphous Metal Transformer (AMT).	
TSO.3.l	Explain the significance of Amorphous Metal Transformer (AMT).		
TSO.4.a	Describe the constructional details of 3-phase 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.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.		
TSO.5.a	Explain the construction and working principle 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**
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.		

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	

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 Interpret 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

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.

A)	**Course Code**	: **2418305(T2418305/P2418305/S2418305)**
B)	**Course Title**	: Python Programming
		(CE, CSE, AIML, ME, ME (Auto)., ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT, RE)
C)	**Pre- requisite Course(s)**	:
D)	**Rationale**	:

Python programming has emerged as a popular programming language across wide range of application segments from Scientific to Machine Learning to mobile app development, and so on. Python is a high-level general-purpose programming language.

Because code is automatically compiled to byte code and executed, Python is suitableuse as a scripting language, Web application implementation language, etc.
In Python there are multiple levels of organizational structure: functions, classes, modules, and packages. These assist in organizing code. An excellentand large example is the Python standard library.

The Object-oriented Python provides a consistent way to use objects: in Python it is easy to implement new object types (called classesin object-oriented programming).
This introductory course to learn basic Python programming features which can be used as building blocks to develop different kind of applications using Python 3.

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 various data types and operators in formation of expressions.

CO-2   Write and execute programs using control statements.

CO-3   Perform relevant operations on Sequence data types

CO-4   Create functions in modules

CO-5   Use numpy in writing python programs

CO-6   Handle data files and exceptions.

F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Developmentof 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	1	-	1	-	-	-	-		
CO-2	1	2	2	1	-	1	-		
CO-3	1	2	2	1	-	1	-		
CO-4	1	2	2	1	-	1	2		
CO-5	1	2	2	1	-	1	-		
CO-6	1	2	2	1	-	1	1		

Legend: High (3), Medium (2), Low (1) and No mapping (-)
  *   PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional.

J)   **Theory Session Outcomes (TSOs) and Units: T2418305**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Differentiate between Procedure Oriented P and Object Oriented Programming approach with example. *TSO 1b.* Use the concept of Lvalue and Rvalue *TSO 1c.* Write python program using various data types and operators	**Unit 1.0 Fundamentals of Python Programming Syntax** 1.1 Introduction to Python Character Set, Python Tokens, Variables, Lvalue and Rvalue Concepts, and the Use of Comments. 1.2 Overview of Data Types: • Number Types: Integer, Floating Point, Complex • Boolean Type • Sequence Types: String, List, Tuple • None Type • Mapping Type: Dictionary • Distinction between Mutable and Immutable Data Types 1.3 Understanding Operators: • Arithmetic Operators • Relational Operators • Logical Operators • Assignment Operator • Augmented Assignment Operators • Expressions and Statements • Type Conversion and Input/Output Mechanisms • Precedence of Operators • Expression Evaluation	**CO-1**
TSO 2a. Write Python program using decision making statements *TSO 2b.* Write Python program using loop structure to solve iterative problems	**Unit-2.0 Conditional and Iterative statements** 2.1 Conditional statements: • simple if statement • if- else statemen • if-elif-else statement 2.2 Iterative statements: • while loop • for loop • range function • break and continue statements • nested loops	**CO-2**
TSO 3a. Perform various operations on string using string operators and methods *TSO 3b.* Perform various operations on List using list operators and methods *TSO 3c.* Perform various operations on tuples using tuples operators and methods *TSO 3d.* Perform various operations on set using set methods	**Unit-3.0 String, List, Tuples, set and Dictionary** 3.1 String: • Indexing • string operations (concatenation, repetition, membership & slicing) • traversing a string using loops • Built-in functions. 3.2 Lists:	**CO-3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3e. Perform various operations on dictionary using dictionary methods	• Introduction • Indexing in list • list operations: concatenation, repetition, membership & slicing, traversing a list, built- in list functions, linear search on list of numbers and counting the frequency of elements in a list 3.3 Tuples: Creating, initializing, accessing elements, tuple assignment, performing operations on tuples, tuple methods and built-in functions, nested tuples 3.4 Set: Creating set, traversing, adding, removing data in set, performing set operations like join, Union intersection, difference 3.5 Dictionary: accessing items in a dictionary using keys, mutability of dictionary: adding a new item, modifying an existing item, built-in dictionary functions.	
TSO 4a. Create and use user defined functions to implement modular programming approach *TSO 4b.* Differentiate variable scope with example. *TSO 4c.* Import and use Python modules, libraries	**Unit-4.0 Python Functions, Modules and packages** 4.1 Functions: types of function (built- in functions, functions defined in module, user defined functions), creating user defined function, arguments and parameters, default parameters, positional parameters, Lambda functions, returning value, scope of a variable: global scope, local scope 4.2 Modules and Packages: Importing module using 'import' Regular Expressions, Exception Handling, PyPI Python Package Index, Pip Python package manager, Importing Libraries and Functions	**CO-4**
TSO 5a. Write simple Python programs using numpy *TSO 5b.* Use Numpy array in python program *TSO 5c.* Use Numpy to solve linear algebra problem.	**Unit-5.0 Numpy** 5.1 Introduction to NumPy 5.2 Installation of NumPy 5.3 NumPy Arrays: • Understanding the NumPy array • The fundamental data structure in NumPy. • Creation of arrays using different methods: np.array(), np.zeros(), np.ones(), etc. • Exploring array attributes like shape, size, and dimensions. 5.4 Array Indexing and Slicing: • Accessing elements and subarrays in NumPy arrays using indexing and slicing. • Demonstration of the difference between one-dimensional and multi-dimensional array indexing. 5.5 Array Operations:	**CO-5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	• Performing element-wise operations on NumPy arrays. • Exploring universal functions (ufuncs) for mathematical operations. 5.6 Linear Algebra with NumPy: • Introduction to linear algebra operations using NumPy. • Matrix multiplication, determinant, inverse, and solving linear equations. 5.7 File input and output with Numpy 5.8 Broadcasting in Numpy	
TSO 6a. Explain different types of Exceptions in python *TSO 6b.* Write Python programs for exception handling in Python *TSO 6c.* Differentiate different modes of file opening. *TSO 6d.* Perform read, Write, Append operations in files	**Unit 6: Exception and File Handling in Python** 6.1 Exception Handling: syntax errors, exceptions, need of exception handling, user-defined exceptions, raising exceptions, handling exceptions, catching exceptions, Try - except - else clause, Try - finally clause, recovering and continuing with finally, built-in exception classes. 6.2 File Handling: text file and binary file, file types, open and close files, reading and writing text files, reading and writing binary files, file access modes	**CO-6**

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

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418305

Practical/Lab Session Outcomes (LSOs)	S.No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Write, execute and debug simple Python program using Integrated Development and Learning Environment (IDLE) *LSO 1.2.* Write and execute simple 'C' program using variables, arithmetic expressions.	1.	a) Download and Install IDLE. Write and execute Python program to- b) Calculate the Area of a Triangle where its three sides a, b, c are given. s=(a+b+c)/2, Area=square root of s(s-a)(s-b)(s-c) (write program without using function) c) Swap Two Variables d) Solve quadratic equation for real numbers.	**CO-1**
LSO 2.1. Write and execute python programs using conditional statements. *LSO 2.2.* Write and execute python programs using various types of Loop statements	2.	Write and execute Python program to- a) Check if a Number is Positive, Negative or zero. b) Check whether the given year is a Leap Year. c) Print all Prime Numbers in an Interval. d) Display the multiplication Table based on the given input. e) Print the Fibonacci sequence. f) Find the Factorial of a Number.	**CO-2**