STATE BOARD OF TECHNICAL EDUCATION, BIHAR

Scheme of Teaching and Examinations for

IVth SEMESTER DIPLOMA IN ELECTRONICS (ROBOTICS) ENGG.

(Effective from Session 2023-24 Batch)

THEORY

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME						
			Periods per Week	Hours of Exam.	Teacher's Assessment (TA) Marks A	Class Test (CT) Marks B	End Semester Exam. (ESE) Marks C	Total Marks (A+B+C)	Pass Marks ESE	Pass Marks in the Subject	Credits
1.	Analog Electronics	2043401	03	03	10	20	70	100	28	40	03
2.	Mechanics of Materials	2043402	03	03	10	20	70	100	28	40	03
3.	Hydraulic & Pneumatic Systems	2043403	03	03	10	20	70	100	28	40	03
4.	Electrical Circuits and Machines	2043404	03	03	10	20	70	100	28	40	03
5.	Sensors and Transducers	2043405	03	03	10	20	70	100	28	40	03
			15				**350**	**500**			**15**

PRACTICAL

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME					
			Periods per Week	Hours of Exam.	Practical		Total Marks (PA+ESE)	Pass Marks in the Subject	Credits
					Internal (PA)	External (ESE)			
6.	Electrical machine Lab	2043406	04	03	15	35	50	20	02
7.	Analog electronics Lab	2043407	04	03	15	35	50	20	02
8.	Hydraulic and Pneumatic Lab	2043408	04	03	15	35	50	20	02
Total:-			**12**				**150**		**06**

TERM WORK

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME				
			Periods per Week	Marks of Internal Examiner (PA)	Marks of External Examiner (ESE)	Total Marks (PA+ESE)	Pass Marks in the Subject	Credits
9.	Minor project	2043409	04	15	35	50	20	02
10.	Block Chain through Moocs /Swaym /(TW)	2043410	02	15	35	50	20	01
	Total:-		**06**			**100**		**03**
	Total Periods per week Each of duration One Hour 33					Total Marks= **750**		**24**

Analog Electronics

Subject Code	Theory			No of Period in one session:42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
2043401	L	T	P/S	ESE	:	70	
	03	—		TA	:	10	
	—	—	—	CT	:	20	

Course Objective:

1. To develop an understanding of small signal amplifier design using linear transistor models.
2. To analysis at low and high frequencies, including different feedback topologies and oscillators.
3. The course also indulges power amplifiers, tuned amplifiers and behavior of noise in an amplifier.

COURSE OUTCOMES (COs):

After completion of the course, a student would be acquainted with the following:

1. Design and analysis of CE, CB, CC amplifiers using small signal h-model and pi- model and derivation of voltage gain, current gain, input impedance and output impedance.
2. Design and analysis of RC coupled single stage and multistage amplifiers and their frequency responses; and the effects of coupling and bypass capacitors in amplifiers.
3. Design and analysis of negative feedback amplifiers and oscillators.
4. Design and analysis of different types of power amplifiers and tuned amplifiers.

Contents :Theory		Hrs
Unit -1	**Linear ICs: Op-amps,** Timers and their applications Operational amplifier – Ideal Op.Amp – Block diagram and characteristics –Op-amp parameters – CMRR – Slew rate – Virtual ground – Applications of op-amp – Inverting amplifier – Summing amplifier – Non inverting amplifier – Voltage follower – Comparator – Zero crossing detector – Integrator – Differentiator – Op- Amp Specifications. 555 Timer – Functional Block diagram – Astable, Monostable and Schmitt Trigger – Sequence timer,555 timer can be used as PWM.	10
Unit -2	**Applications Of Operational Amplifiers** Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtraction, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band pass Butterworth filters.	08
Unit – 3	**Analog to digital and digital to analog converters** Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode R2R Ladder types switches for D/A converters, high speed sample-and-hold circuits, A/D Converters specifications Flash type – Successive Approximation type Single Slope type – Dual Slope type - A/D Converter using Voltage- to-Time Conversion – Over sampling A/D Converters.	0812
Unit – 4	**Waveform generators and special function** ICs Sine-wave generators, Multivibrators and Triangular wave generator, Saw tooth wave generator ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator Monolithic switching regulator Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto- couplers and fiber optic IC.	10

Unit-5	**Analog Multiplier and PLL** Analog Multiplier using Emitter Coupled Transistor Pair -Gilbert Multiplier cell – Variable trans conductance technique, analog multiplier ICs and their applications, Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing.	**06**

Suggested Text Books:

1. Analog Circuits by A.K. Maini Khanna Publishing House Ed. 2018
2. Electronic Devices and Circuits by S. Saliva Hanan and N. Suresh Kumar McGraw Hill Education
3. Electronics Devices and circuit theory Boylested & Nash- Elsy Pearson Education India
4. Electronic Principles Albert Melvino & David Bates Tata McGraw Hill Publication
5. Electronics Devices &Circuits Jacob Millman McGraw Hill Education
6. OP-AMP and Linear ICs Ramakant A.Gayakwad Prentice Hall / Pearson Education.
7. Linear Integrated Circuits Deepak Sinha FPH (Foundation Publishing House).
8. Operational Amplifier and Linear Integrated Circuits K Lal Kishore Pearson Education, 2006.

Mechanics of Materials

Subject Code	Theory			No of Period in one session:42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
2043402	L	T	P/S	ESE	:	70	
	03	—		TA	:	10	
	—	—	—	CT	:	20	

Course Objective:

1. Define various mechanical properties of materials.
2. Calculate the deformation of materials, which are subjected to axial Load and shear
3. Determine the moment of inertias of various section used in the industry.
4. Estimate the stresses used in thin cylinder under internal pressure.
5. Draw the graphical representation of shear force and bending moment of the Beam subjected to different Load.
6. Construct SFD and BMD.
7. Calculate the power transmitted by the solid & hollow shafts.
8. Distinguish different types of spring and their applications.
9. Define Types of Friction.

COURSE OUTCOMES (COs):

1. Explain the theory, concepts, principles and governing equations of solid mechanics.
2. Demonstrate the ability to deconstruct complex problems to produce effective outcomes.
3. Use analytical, experimental and computational tools needed to solve the idealized problem.
4. Demonstrate the independent judgment required to interpret the results of these solutions.
5. Use these solutions to guide a corresponding design, manufacture, or failure analysis.
6. Explain the selection, design and stress analysis of composite materials.
7. Analyze the stresses in simple structures as used in the aerospace industry.

Contents: Theory

	Name of the Topic	Hrs
Unit -1	**DEFORMATION OF METALS** **Mechanical properties of materials** Engineering materials – Ferrous and nonferrous materials -Definition of mechanical properties such as strength –elasticity, plasticity, ductility, malleability, stiffness, toughness, brittleness, hardness, wear resistance, machinability, cast ability and weld ability—Alloying elements-effect of alloying element - Fatigue, fatigue strength, creep –temperature creep – cyclic loading and repeated loading – endurance limit.	06
Unit -2	**Simple stresses and strains** Definition – Load, stress and strain – Classification of force systems – tensile, compressive and shear force systems –Behavior of mild steel in tension up to rupture – Stress – Strain diagram – limit of proportionality – elastic limit – yield stress – breaking stress – Ultimate stress – percentage of elongation and percentage reduction in area – Hooke's law – Definition – Young's modulus - working stress, factor of safety, load factor, shear stress and shear strain - modulus of rigidity. Linear strain – Deformation due to tension and compressive force – Simple problems in tension, compression and shear force. Definition – Lateral strain – Poisson's ratio – volumetric strain – bulk modulus –volumetric strain of rectangular and circular bars – problems connecting linear, lateral and volumetric deformation – Elastic constants and their relationship -Problems on elastic constants Definition – Composite bar – Problem in composite bars subjected to tension and compression.	10

Unit – 3	**GEOMETRICAL PROPERTIES OF SECTIONS AND THIN CYLINDERS AND THIN SPERICAL SHELLS** Properties of sections: Definition – center of gravity and centroid - position of centroids of plane geometrical figures such as rectangle, triangle, circle and trapezium-problems to determine the centroid of angle, channel, T and I sections only - Definition-centroidal axis-Axis of symmetry. Moment of Inertia –Statement of parallel axis theorem and perpendicular axis theorem. Moment of Inertia of lamina of rectangle, circle, triangle, I and channel sections-Definition-Polar moment of Inertia-radius of gyration – Problems computing moment of inertia and radius of gyration for angle, T, Channel and I sections. **Thin Shells:** Definition – Thin and thick cylindrical shell – Failure of thin cylindrical shell subjected to internal pressure – Derivation of Hoop and longitudinal stress causes in a thin cylindrical shell subjected to internal pressure – simple problems – change in dimensions of a thin cylindrical shell subjected to internal pressure – problems – Derivation of tensile stress induced in a thin spherical shell subjected to internal pressure – simple problems – change in diameter and volume of a thin spherical shell due to internal pressure – problems.	10
Unit – 4	**LATERAL DEFORMATION (SF AND BM DIAGRAMS, THEORY OF SIMPLE BENDING)** Classification of beams – Definition – shear force and Bending moment – sign conventions for shear force and bending moment – types of loadings –Relationship between load, force and bending moment at a section – shear force diagram and bending moment diagram of cantilever and simply supported beam subjected to point load and uniformly distributed load (udl) – Determination of Maximum bending moment in cantilever beam and simply supported beam when they are subjected to point load and uniformly distributed load. THEORY OF SIMPLE BENDING Theory of simple bending – Assumptions – Neutral axis – bending stress distribution – moment of resistance – bending equation – M/I=f/y=E/R – Definition – section modulus - rectangular and circular sections – strength of beam – simple problems involving flexural formula for cantilever and simple supported beam.	10
Unit – 5	**TORSION AND SPRINGS Theory of torsion** Assumptions – torsion equation – strength of solid and hollow shafts – power transmitted – Definition – Polar modulus – Torsional rigidity – strength and stiffness of shafts – comparison of hollow and solid shafts in weight and strength considerations – Advantages of hollow shafts over solid shafts – Problems. Types of springs – Laminated and coiled springs and applications – Types of coiled springs – Difference between open and closely coiled helical springs –closely coiled helical spring subjected to an axial load – problems to determine shear stress, deflection, stiffness and resilience of closed coiled helical springs.	06

Suggested Text Book/**Reference Book:**

1. Strength of Materials ,R. S. Khurmi, , S.Chand & Co., Ram Nagar, New Delhi – 2002
2. Strength of Materials, S. Ramamrutham, 15 th Edn 2004, DhanpatRai Pub. Co., New Delhi.
3. Strength of Materials ,R.K. Bansal,, Laxmi Publications Pvt. Ltd., New Delhi, 3rd Edition, 2010.
4. Strength of materials, S.S.Rattan, Tata Mcgraw hill, New Delhi,2008, ISBN 9780070668959.
5. Strength of Materials, B K Sarkar, I Edition, 2003 Tata Mcgraw hill, New Delhi.
6. Engineering mechanics, R.K. Bansal, Laxmi Publications Pvt. Ltd., New Delhi, 2nd Edition, 2007

Hydraulic and Pneumatic system

Subject Code 2043403	Theory						Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objective:

1. To Understand & Explain various types of piston pump and gear pumps.
2. To Familiarize & Explain various linear and rotary actuators.
3. To Understand & Explain various directional and pressure control valves.
4. To Understand & Explain Various Hydraulic and Pneumatic systems.
5. To Understand & Explain Various Directional Control valves.

COURSE OUTCOMES (COs):

After the completion of course, students will be able to

1. Understand hazards of hydraulic and pneumatic circuits and be able to work safely.
2. Understand the concepts of fluid statics and dynamics as applied to commercial and industrial control.
3. Recognize standard schematic symbols for common fluid power components.
4. Understand and troubleshoot basic fluid power, electro-hydraulic, and electro-pneumatic circuits using schematic diagrams.

CONTENTS: THEORY

Name of the Topic		Hrs
Unit -1	**Fluid Power, Pumps.** Fluid Power –Definition –Pascal's Law- Basic Properties Of Hydraulic Fluids- Mass , Weight, Density, Specific Weight, Specific Gravity, Viscosity, Bulk Modulus. Hydraulic Pumps Classification -Pump Types- Piston Pumps –Axial Piston Pump Radial Piston Pumps- Graphical Symbols – Working Principles only. **Gear Pumps-** External Gear Pump- Internal Gear Pumps. Graphical Symbols – Working Principles only. Vane Pump Unbalanced Vane Pump – Balanced Vane Pump- Graphical Symbols – Working Principles only.	12
Unit -2	**Linear actuators** Rotary actuators. Linear Actuators- Hydraulic Cylinders - Cylinder Types-Single Acting cylinder -Gravity Return cylinder–Spring Return cylinder - Telescopic Cylinder – Hydraulic Ram –Tandem Cylinder , Symbols and working principles only- Rotary actuators-motor types – gear motor-balanced vane motor-piston motor –two vane rotor actuator-rack AND pinion rotary actuator-motor torque – speed – power –efficiency –symbols –applications – specifications.	12
Unit -3	**Directional control valve** pressure control valve and Flow control valve Directional Control Valves:-Check Valve-Shuttle Valves-Two Way Directional Control Valves -Three Way Directional Control Valves - Four Way Directional Control Valves – Directional Control Valves Actuation types-Symbols-Working Principles- Pressure Control Valve: Pilot Operated, Pressure Relief Valve –Pressure Reducing Valve –Sequence Valve – Symbols- Working Principles Flow Control Valve –Type –Needle Valve –Pressure Compensated Flow Control Valve-Cushioned Cylinders –Flow Dividers –Balanced Spool Flow Divider- Rotary Flow Divider .	10

Unit -4	**Hydraulic components, Instrumentation and Measurement, Conduits and Fittings, Hydraulic circuits:** Hydraulic Components –Accumulators – types –Diaphragm - Spring Loaded -Weight Loaded -Pressure Intensifiers – Hydraulic Reservoirs-Heat Exchanger types- Air cooled –Water cooled - Filters. Instrumentation and Measurement: Pressure Gauges-Flow meters- Temperature Gauges Conduits and Fittings-Pipe - Tubing –Hose - Seals and Bearings – Hydraulic Fluids. Hydraulic Circuits:-Counter Balance Circuit –Sequence Circuit Speed Control Circuit-Meter in Circuit –Meter Out Circuit Intermittent Feed Control-Speed Control For Continuous Processing – Booster and Intensifier Circuits-Force Multiplication – Pressure Intensification.	11
Unit -5	**Pneumatics system, Electronic control for Fluid power** Pneumatics - Basic principles of pneumatics-difference between hydraulics and pneumatics-compressor types-two stage piston compressor –rotary vane compressor-rotary screw compressor – vacuum pumps- double acting pneumatic cylinder–gear motorpressure regulator –filters-lubricators-FRL unit-water removal – air preparation and distribution – **Electronic control of fluid power -** **Solenoid valves-servo valves pump controls.**	15

Suggested Text Books/Reference Books:

1. Industrial Hydraulics –Third Edition John J.PippengerTyler,G.Hicks.Mc.Graw-HillBook Companys.
2. Introduction To Fluid Power--James L. Johnson. -Delmar Thomson Learning Inc.
3. Fluid Power Technology-Robert P. Kokernale-Library Of Congress CatalogingPublication Data.
4. Basic Fluid Power - Dudleyt, A Pease and John J Pippenger - Prentice Hall 1987.

Electrical circuits and machines

Subject Code 2043404	Theory						Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objective:

1. Define voltage, current, resistance, resistivity, power, energy and their units.
2. State and explain ohm's law and Kirchhoff's law and solve simple problems.
3. Derive equivalent resistance of series and parallel circuits.
4. Solve problems in mesh current and nodal voltage method.
5. State and explain super position theorem, Thevenin's theorem, Norton's theorem and maximum power transfer theorem and solve problems in theorems.

CONTENTS: THEORY

	Name of the Topic	Hrs
Unit -1	**DC Circuits and DC Network Theorems** Concept of electrical quantities – Voltage – current – resistance –power – energy – ohm's law – Resistances in series – Resistances in parallel – series parallel circuits – Kirchhoff's laws Super position, Thevenin's, Norton's and maximum power transfer theorems – Statement and explanations – Simple problems.	12
Unit -2	**AC Circuits** AC fundamentals – AC waveform – sinusoidal and non-sinusoidal– period – frequency – cycle – amplitude – phase – peak value – average value – RMS value (effective value) – form factor – crest factor AC Through pure resistor, inductor and Capacitor – Concept of impedance – vector diagram. Capacitors in series and parallel –energy stored in a capacitor– derivation – simple problems. Power in AC circuits – power factor– RL, RC and RLC series and parallel circuits – simple problems. Introduction of Harmonics -Effects of Harmonics	06
Unit – 3	**Resonance and 3 AC circuits** Resonance – condition for resonance – series and parallel resonance – resonance curve – effect of resistance on resonance curve – selectivity – Q factor and bandwidth – applications of resonance – simple problems in resonance. Concept of 3 supply – line and phase voltage and current in star and delta connected circuits – three phase power – Measurement of three phase power by two-watt meter method – simple problems – advantages of three phase over single-phase system.	12
Unit – 4	**D.C Machines and A.C Machines** DC machines – Types – constructional details of DC machines –DC generators – principle – types – emf equation –characteristics of shunt, series and compound generators DC motor – types – motor action – back emf – torque speed characteristics – starting of motors using 3- and 4-point starters –speed control of DC motor-applications.AC machines – 3 alternator – construction and working – relation between speed and frequency. 3 Induction motor – construction– types – principle of operation – methods of starting of 3induction motor – slip. Single phase induction motor – principle of operation – capacitor start - motors – Applications – principle of operation -Stepper motor.	10

Unit-5	**Transformers** Transformer – Ideal transformer – principle of working –constructional details – emf equation – turns ratio – core loss – copper loss – efficiency – regulation – SC and OC tests – simple problems. Transformer on No load – Transformer on load – condition for maximum efficiency – All-day efficiency (simple problems). Autotransformer – construction and working – applications**.**	10

Suggested Text Book/Reference Books:

1. Networks and Systems Ashfaq Husain Khanna Publishing House
2. Network Analysis M. E. Van Valkenburg Prentice Hall of India
3. Engineering Circuit AnalysisW. H. Hayat, J. E.Kemery and S. M.Durbin McGraw Hill
4. Electrical Circuits Joseph Ed minister Schumm's Outline, Tata McGraw Hill
5. Basic Circuit Theory Lawrence P.Huelsman Prentice Hall of India
6. Network & Systems D. Roy Choudhury Wiley Eastern Ltd
7. Linear Circuit Analysis De Carlo and Lin Oxford Press

Sensors and Transducers

Subject Code 2043405	Theory			No of Period in one session:42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objectives:

To enable the students to select and design suitable instruments to meet the requirements of industrial applications and various transducers used for the measurement of various physical quantities and the following:

1. Various types of Sensors & Transducers and their working principle
2. Resistive, Capacitive and Inductive transducers
3. Some of the miscellaneous transducers
4. Characteristics of transducers

Course Outcomes:

1. Student will be able to Distinguish, analyse different types of errors.
2. Students will be able to apply transforms to obtain the characteristics of transducers.
3. Students will be able to analyse the working principles of sensors and transducers.
4. Students will be able to select and design suitable instruments to meet the requirements of industrial applications and various transducers used for the measurement of various physical quantities

CONTENTS: THEORY

8.

	Name of the Topic	Hrs
UNIT-1	Block Schematics of Measuring Systems, Performance Characteristics, Static Characteristics, Accuracy, Precision, Resolution, Types of Errors, Gaussian Error, Root Sum Squares formula, Dynamic Characteristics, Repeatability, Reproducibility, Fidelity, Lag	12
UNIT-2	Sensor, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchronous and Resolvers, Induction Potentiometers, Micro Electromechanical Systems.	15
UNIT-3	Measurement of temperature using Thermistor, Thermocouple & RTD, Concept of thermal imaging, Flow Sensors: Ultrasonic & Laser, Level Sensors: Ultrasonic & Capacitive.	08
UNIT-4	Intelligent Sensors: General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control	09
	Total	42

Reference Books:

1. Arun K Ghosh, "Introduction to Transducers", PHI Publication.
2. Bela G. Liptak, "Process Measurement and Analysis, Vol. 1", CRC Press Publication

Electrical machine Lab

Subject Code	Practical						Credits
2043406	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal (PA)	:	15	
	—	—	04	External (ESE)	:	35	

OBJECTIVES:

- Verify the Thevenin's Theorem
- Verify Ohms law and super position theorem
- Verify maximum power transfer theorem
- Demonstrate the frequency response plot for series and parallel resonance
- Conduct load test on single phase transformer
- Conduct Load test and No-Load test on DC generator

List of Experiments

1. Verify Ohm's law.
2. Verify Kirchhoff's current Law.
3. Verify Kirchhoff's Voltage Law.
4. Test and Verify Maximum Power Transfer theorem.
5. Test and verify Super position theorem.
6. Test and verify Thevenin's Theorem.
7. Determine the frequency response of series resonance.
8. Determine the frequency response of parallel resonance.
9. Measurement of power and power factor of single-phase load and plot the graph.
10. Speed control of DC motor using DIAC and TRIAC.
11. Speed control of AC motor using DIAC and TRIAC.
12. Predetermine the efficiency and regulation by open circuit and short circuit test on single phase transformer.
13. Conduct Load test on DC Generator.
14. Conduct Load test on Single phase transformer.

Experiment title	Lab session learning outcomes
1.Verify Ohm's law.	(a) Identify different measuring instruments. (b) Tabulate measured voltage between terminals by identifying AC/DC supply terminals. (c) Use an analog multimeter to record different readings. (d) Record the readings by connecting analog voltmeter and analog ammeter. (e) Plot the graph between voltage and current. (f) Follow safe practices.
2.Verify Kirchhoff's current Law.	(a) Mention circuit elements as per I.S. (b) Use a multimeter to measure -The voltage across the terminals, the current flowing in the circuit and the resistance of the load. (c) Record the readings by connecting analog voltmeter and analog ammeter. (d) Follow safe practices.
3. Verify Kirchhoff's Voltage Law.	(a) Construct the resistive circuits with appropriate resistors.

	(b) Identify AC/DC supply terminals and tabulate the measured voltage between terminals. (c) Measure the voltage around closed path with the help of ammeter and voltmeter. (d) Verify the theoretical value with measured value. (d) Follow safe practices.
4. Test and Verify Maximum Power Transfer theorem.	(a) Identify different types of rheostats, like wire wound, water rheostat. (b) Construct the resistive circuits with appropriate resistors/rheostat. (c) Calculate the Thevenin resistance and power transfer to the load. (d) Measure the experimented value. (e) Verify the theoretical value with measured value. (f) Follow safe practices.
5. Test and verify Super position theorem.	(a) Construct the resistive circuits with appropriate voltage source. (b) Calculate the current flowing through circuit using one source at a time and replace other sources with its internal impedance. (c) Measure the experimented value. (e) Verify the theoretical value with measured value. (f) Follow safe practices.
6.Test and verify Thevenin's Theorem.	(a) Construct the resistive circuits with appropriate electrical circuit elements. (b) Calculate the Thevenin equivalent impedance and Thevenin voltage source. (c) Measure the experimented value. (e) Verify the theoretical value with measured value. (f) Follow safe practices.
7.Determine the frequency response of series resonance.	(a) Assemble the series resonance circuit with appropriate circuit components. (b) Measure the frequency using audio frequency generator and record the different readings. (c) Calculate the frequency at which voltage attains its maximum value, after it voltage deceases. (d) Plot a graph between voltage and frequency. (e) Follow safe practices.
8. Determine the frequency response of parallel resonance.	(a) Measure the value of the resistor R, capacitor and inductor. (b) Set the function generator amplitude to$5V_{PP}$; frequency to300 Hz, sine wave. (c) Measure the function generator voltage and frequency with the oscilloscope. (d) Connect the circuit appropriately on the breadboard. (e) Plot a graph between voltage and frequency. (f) Follow safe practices.

9.Measurement of power and power factor of single-phase load and plot the graph.	(a) Measure the basic electrical quantities such as voltage, current and power and power factor for variable R-load. (b) Follow uses of autotransformers. (c) Demonstrate connections of meters used for AC quantities measurement. (d) Measure the apparent power reading using ammeter and voltmeter. (e) Verify the measured power factor with calculated power factor. (f)Procedure is repeated for different values of load resistances. (g) Follow safe practices.
10. Speed control of DC motor using DIAC and TRIAC.	(a) Connect DC motor unit with main unit through patch cords. (b) Connect the main lead of instrument in the mains plug. (c) Use potentiometer and know how to operate attenuation lead. (d) Note down the reading on the current meter at equal interval of voltage by varying speed of DC motor. (e) Follow safe practices.
11.Speed control of AC motor using DIAC and TRIAC.	(a) Connect AC motor unit with main unit through patch cords. (b) Connect the main lead of instrument in the mains plug. (c) Use potentiometer and know how to operate attenuation lead. (d) Note down the reading on the current meter at equal interval of voltage by varying speed of AC motor. (e) Follow safe practices.
12.Predetermine the efficiency and regulation by open circuit and short circuit test on single phase transformer.	(a) Observe the performance of a transformer at various levels of load by knowing all the equivalent circuit parameters. (b) Assemble the circuit appropriately for open and short circuit connection. (c) Calculate the rated voltage, input or no load current and input power. (d) Define Iron losses and copper losses. (e) Calculate the Iron losses and copper losses using efficiency equations. (f) Follow safe practices while handling electronic equipment's.
13.Conduct Load test on DC Generator.	(a) Connections are made as per the circuit diagram. (b) Observe all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. (c) Calculate the field current and corresponding induced emf. (d) Draw the characteristics at constant rated speed by adjusting the drive unit or motor filed resistance as required. (f) Follow safe practices while handling electronic equipment's.
14.Conduct Load test on Single phase transformer.	(a) Connections are made as per the circuit diagram. (b) Ensure that the field rheostat and Pot meter of Drive Control Unit are in minimum position and the field rheostat of Generator should be in its maximum position. (c) observe all precautions until motor is started using Drive Control and the speed is increased until the rated armature voltage is reached. (d) Follow safe practices while handling electronic equipment's.

Analog electronics Lab

Subject Code 2043407	Practical						Credits
	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal (PA)	:	15	
	—	—	04	External (ESE)	:	35	

List of Experiments:

1. To study the characteristics of Operational Amplifiers (IC741).
2. To study the Waveform Generation using Op-Amp (IC741).
3. To study the Applications of Timer IC555.
4. To Design of Active filters.
5. To Study the application of PLL IC's.
6. To Design of binary adder and subtractor.
7. To Design of counters.
8. To Study of multiplexer and demultiplexer /decoders.
9. Implementation of combinational logic circuits.
10. Study of DAC and ADC.
11. Study of Op-Amp voltage Regulator- IC 723.

Experiment title	Lab session learning outcomes
1.To study the characteristics of Operational Amplifiers (IC741).	(a) Select appropriate settings to calibrate the CRO. (b) Verify the required value of power supply output using CRO (c) Observe the open loop transfer characteristics on CRO. (d) Sketch the output waveforms on butter paper from CRO screen. (e) Follow safe practices while handling electronic equipment's.
2. To study the Waveform Generation using Op-Amp (IC741).	(a) Select appropriate settings to calibrate the CRO. (b) Verify the required value of power supply output using CRO. (c) Select appropriate values of passive components for output frequency. (d) Connect the identified components to form Wave

	generator circuit on breadboard. (e) Observe the output waveform and find the frequency of oscillation. (f) Follow safe practices while handling electronic equipment's.
3. To study the Applications of Timer IC555.	(a) Select appropriate settings to calibrate the CRO. (b) Verify the required value of power supply output using CRO. (c) Select appropriate values of passive components for output frequency. (d) Connect the identified components to form Astable Multivibrator and monostable multivibrator circuit on breadboard. (e) Observe the output waveform and find the frequency of oscillation. (f) Calculate the duty cycle and pulse width of the waveform. (g) Follow safe practices while handling electronic equipments.
4. To Design of Active filters.	(a) Select appropriate settings to calibrate the CRO and Function Generator. (b) Verify the required value of power supply output using CRO. (c) Select appropriate values of passive components required for Active filters. (d) Connect the identified components to form Active filter Circuit on the breadboard. (e) Plot the filter response and calculate the cut-off frequency of the Active filter. (f) Follow safe practices while handling electronic equipments.
5. To Study the application of PLL IC's.	(a) Select appropriate settings to calibrate the CRO and Function Generator. (b) Verify the required value of power supply output using CRO. (c) Select appropriate values of passive components.

	(d) Connect the identified components to IC-565 to form PLL circuit. (e) Observe the lock and capture range on CRO. (f) Follow safe practices while handling electronic equipment's.
6. To Design of binary adder and subtractor.	(a) Connection to be made as per the circuit diagram of binary adder and subtractor. (b) Draw the truth table of the logic gates. (c) Perform the experiment by giving all the possible input variations. (d) Observe the output and verify the truth table. (e) Follow safe practices while handling electronic equipment's.
7. To Design of counters.	(a) Connections to be made as per the circuit diagram. (b) Draw the truth table of the logic gates. (c) Verify the truth table by giving clock pulse. (d) Observe the output with truth table. (e) Follow safe practices while handling electronic equipment's.
8. To Study of multiplexer and demultiplexer /decoders.	(a) Connections to be made as per the circuit diagram of multiplexer and demultiplexer. (b) Demonstrate the experiments by giving logical inputs as per circuit diagram. (c) Observe the output and verify the truth table. (d) Follow safe practices while handling electronic equipment's.
9. Implementation of combinational logic circuits.	(a) Describe the Boolean algebra, logic gates and K-MAP. (b) Examine the IC in the IC Trainer Kit, and identify the different leads/pins of the IC before making connection. (c) Demonstrate the experiments by giving logical inputs as per circuit diagram. (d) Follow safe practices while handling electronic equipment's.
10. Study of DAC and ADC.	(a) Define various terms of A/D and D/A converters. (b) Understand the advantages, disadvantages, and limitations of several types of (DAC) and ADC.

11. Study of Op-Amp voltage Regulator- IC 723.	(a) Setup the circuit on the breadboard and check the connections. (b)Select the appropriate settings of unregulated voltage from 7.5V to 35V and observe the output voltage. (c) Calculate the line and load regulation for the regulator. (d) Plot the graphs from the observations. (e) Follow safe practices while handling electronic equipment's.

Hydraulic and Pneumatic Lab

Subject Code 2043408	Practical						Credits
	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal (PA)	:	15	
	—	—	04	External (ESE)	:	35	

Lists of Practical's:

1. Study of Pneumatic system and its elements- pressure control valve (PCV),
2. Directional control valve (DCV) and Flow control Valve (FCV)
3. Direct operation of a single Acting cylinder.
4. Direct operation of Double Acting cylinder.
5. Operation of a Double Acting cylinder with Quick exhaust valve.
6. Speed control of Double Acting cylinder using metering in and metering out circuit.
7. Automatic operation of Double Acting cylinder in multi cycles -Using limit switches and memory valves.
8. Automatic operation of Two Double Acting cylinder in multi cycles -Using limit switches and memory valves in the following sequence.
   a. A+B+A-B
   b. A-B+A+B
   c. A+B+B-A
   d. A-B+A-B
9. Operation of a Double Acting cylinder using solenoid operated Directional control valve.

HYDRAULICS LAB

1. Study of hydraulic system and its elements.
2. Direct operation of Double Acting cylinder.
3. Direct operation of Hydraulic Motor.
4. Speed control of Double Acting cylinder - Using metering-in and metering out control.
5. Speed control Hydraulic Motor - Using metering-in and metering-out control.
6. Automatic operation of Double Acting cylinder in multi cycles -Using pressure sequencing valve
7. Operation of a Double Acting cylinder using solenoid operated Directional control valve.
8. Automatic operation of Two Double Acting cylinder in multi cycles –Using solenoid valves and proximities in the following sequence
   a. A+B+A-B
   b. A-B+A+B
   c. A+B+B-A
   d. A-B+A-B

Minor Project

Subject Code 2043409	Practical						Credits
	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal (PA)	:	15	
	—	—	04	External (ESE)	:	35	

List of Practical's:

1. Identify components and different configurations of robots.
2. Pick/hold different objects (shape/weight/stiffness) using robot end effecters.
3. Assemble robot to test various configurations and degrees of freedom using robot trainer kit.
4. Use different types of robotic sensors for a specific situation.
5. Perform robot control with stepper motor interfacing.
6. Assemble robot arms using mechanical transmission components and interface motor drive.
7. Perform pick and place operation using Simulation Control Software.
8. Perform 2D simulation of a 3 DOF robot arm.

Experiment title	Lab session learning outcomes
1. Identify components and different configurations of robots.	(a) Identify parts of Robot on the basis of function. (b) Identify joint type & link parameters (link length, link twist, and Link offset), rotational vs. linear motion, used in robot.
2. Pick/hold different objects (shape/weight/stiffness) using robot end effecters.	(a) Identify different types of robot end effecters. (b) Use Mechanical grippers to hold objects. (c) Use Vacuum grippers to hold objects.
3. Assemble robot to test various configurations and degrees of freedom using robot trainer kit.	(a) Assemble the complete robot using the components as per the procedure. (b) Apply the functionalities available in rotor trainer kit. (c) Test for various configurations. (d) Test for various degrees of freedom.
4. Use different types of robotic sensors for a specific situation.	(a) Identify various types of sensors used in robotic application. (b) Measure angular motion using Synchro's. (c) Detect objects using optical sensors.
5. Perform robot control with stepper motor interfacing.	(a) Interface stepper motor. (b) Control robot with stepper motor interfacing.
6. Assemble robot arms using mechanical transmission components and interface motor drive.	(a) Draw the labelled sketch of individual parts and robot arm. (b) Assemble the arm using the parts as per the procedure. (c) Interface the motor drive and operate.
7. Perform pick and place operation using Simulation Control Software.	(a)Use open source or available relevant software to develop pick and place programme. (b)Perform simulation.
8. Perform 2D simulation of a 3 DOF robot arm.	(a) Develop programme for using a robot arm with three degrees of freedom. (b) Execute the programme.

BLOCK CHAIN THROUGH MOOCS / SWAYAM / (TW)

Subject Code (2043410)	Term Work						Credits
	No. of Periods Per Week			Full Marks	:	50	01
	L	T	P/S	Internal	:	15	
	-	-	02	External	:	35	