

Maharashtra State Board of Vocational Examination, Mumbai 400 051

1	Name of Course	Diploma Course in Mechanic Mechatronics									
2	Course code	301416									
3	Max no. of Students	25									
4	Duration	2 year									
5	Course Type	Full Time									
6	No. of Days per week	6 days									
7	No. of hours per day	7 Hrs									
8	Space require	Theory Class Room – 240 sqft Practical Lab – 540 sqft									
9	Entry qualification	S.S.C. Pass									
10	Objective of syllabus	To undertstnd basic Electricity, Electronics. To understand use of electricity and electronics in mechanical engineering. To maintain and repair various mechanical tools and equipment based on electronics application									
11	Employment opportunities	work as Mechanic in Mechanical product manufacturing industry using electronics.									
12	Teachers Qualification	For Vocational Subject - B. E. Electronics or Equivalent and For Non Vocational Subject - Master Degree in concern Subject.									
13	Teaching Scheme –										
	Sr.	Subject	Subject Code	Clock Hours / Week			Total				
				Theory	Practical						
	1	English (Commu- nication Skill) 90000001	90000001	2 Hrs	1 Hrs	3 Hrs					
	2	Elective – I	--	2 Hrs	1 Hrs	3 Hrs					
	3	Elective – II	--	2 Hrs	1 Hrs	3 Hrs					
	4	Basic Electricity and Measurement	30140018	3 Hrs	8 Hrs	11 Hrs					
	5	Basic Electronics	30140019	3 Hrs	8 Hrs	11 Hrs					
	6	Mechatronics Theory	30140020	3 Hrs	8 Hrs	11 Hrs					
	Total									42 Hrs	
14	Internship	Two Month Summer Internship from 1 st May to 30 th June is Compulsory.									
15	Examination Scheme – Final Examination will be based on syllabus of both years.										
	Paper	Subject	Subject Code	Theory			Practical			Total	
				Duration	Max	Min	Duration	Max	Min	Max	Min
	1	English (Commu- nication Skill) 90000001	90000001	3 Hrs	70	25	3 Hrs	30	15	100	40
	2	Elective – I	--	3 Hrs	70	25	3 Hrs	30	15	100	40
	3	Elective – II	--	3 Hrs	70	25	3 Hrs	30	15	100	40
	4	Basic Electricity and Measurement	30140018	3 Hrs	100	35	3 Hrs	100	50	200	85
	5	Basic Electronics	30140019	3 Hrs	100	35	3 Hrs	100	50	200	85
	6	Mechatronics Theory	30140020	3 Hrs	100	35	3 Hrs	100	50	200	85
	Total									900	375
16	Teachers – Three Teachers per batch for vocational component. For English, Elective-I & II guest faculty on clock hour basis.										
17	a) For Elective I – Student can choose any one subject						b) For Elective II – Student can choose any one subject				
	Code	Subject Name				Code	Subject Name				
	90000011	Applied Mathematics				90000021	Applied Sciences (Physics & Chemistry)				
	90000012	Business Economics				90000022	Computer Application				
	90000013	Physical Biology (Botany & Zoology)				90000023	Business Mathematics				
	90000014	Entrepreneurship									
	90000015	Psychology									

Subject Code: 30140018

Subject Name : Basic Electricity and Measurement

1. Conducting material

- 1.1 Conducting material-Properties, Classification,
- 1.2 Characteristics of good/Bad Conductors, Semi/Super Conductors and their Applications.
- 1.3 Bare Conductors, O.H. Conductors, ACSR, Copper Aluminum G. I., , winding wires Bus Bars ,
- 1.4 Wires & Cables, L.T.& H.T. Cables Conductors.
- 1.5 Requirements of Resistive Material.
- 1.6 Properties of Resistive material.
- 1.7 Types of Resistive Material.

2. Insulating material

- 2.1 Properties of Insulating material, Classifications,
- 2.2 Types w. r. t. Thermal sensitivity Insulating material & its Die electric strength Solid, Liquid & Gas)
- 2.3 Insulation material Required for--Winding wires, Cables/ wires (HT & LT), O.H. Insulators (Advance) HT & LT, Switch gear
- 2.4 Die electric medium its properties. .

3. Semi Conductor material

- 4.1 Characteristics of semi conductors material.
Semi conductor alloys, oxides, sulphides & Halides etc.
- 4.2 Commonly used semi conductor material and their Application.

4. Magnetic material

- 5.1 Requirements of magnetic material Permanent Magnetic material,
- 5.2 Magnetic material used for cores (CRGO, Ferrites) Application.

5. Special Application of materials

- 6.1 Contact material- slip ring, force free spring, carbon brushes, Brush Holder, commutator, Switch gear, Contacts
- 6.2 Thermocouple materials,
- 6.3 Bimetal materials,
- 6.4 Soldering materials, Fuse materials

6. Cell and Batteries

- 7.1 Requirements of Cell and Batteries materials
- 7.2 Primary Cells description, Classification
- 7.3 Secondary Cells , Classification Lead Acid Battery, Construction, Nicel Battery
Maintenance free Battery
- 7.4 Maintenance, installation, applications, write off procedures..

7. Electrostatics
 - 1.1 Voltage & Die-Electric Strength (concepts only)
 - 1.2 Principle of Capacitor. Capacitance, Series / Parallel Combination Charging & Discharging of Capacitor.

8. Electric Current & Circuits
 - 2.1 Concepts & Types of circuit., Ohm's Law, Factors Controlling the 'R' of material. Effect of Temp., Law of Resistance, Resistivity etc.
 - 1.2 Polarity of 'IR' Drops. Internal Resistance, Potentiometer- Construction & Applications. Shunts-Applications.

9. Network Circuits
 - 3.1 Kirchoff's Laws (KCL, KVL), Simple problems, Wheatstone's Network, Meter Bridge & Applications.
 - 3.2 Simple numerical Problems

10. Electro- Chemistry
 - 4.1 Chemical effects of Electric current, Faraday's Laws of Electrolysis- E.C.E., Applications of Electrochemistry,

11. Thermo- Electricity
 - 5.1. Heating effect of elect. Current, Joule's Law Thermocouple, See-back effect, & Application.
 - 5.2 Simple Calculations on Joule's Law Electric Power, Energy, Calculations on Power & Energy (Elect. Bills).

12. Electro-magnetism.
 - 6.1 Permeability, Laws of Magnetic Forces, Definitions Of Mag. Field strength, Flux density, Intensity of Magnetism,, MMF, Ampere-Turns, Reluctance. Etc. Comparison between Mag. Field & Elect. Field.
 - 6.2 Ampere's Rule, Laplace's Law, Force on current carrying conductor in Mag. Field, Fleming's Left Hand Rule. Force between two parallel current carrying conductors, Solenoid.
 - 6.3 Faraday's Laws of Electromag. Induction. Magnitude of Dynamically & Statically induced EMF, Eddy current. Lenz's Law, Magnetic Losses-

13. A. C. Fundamentals
 - 7.1 Generation & Equation of Alternating Voltages & Currents, Definitions of Phase, Phase Difference, Max. / Peak Value, R.M.S. Value. Average Value etc.
 - 7.2 Vector algebra of A.C. Quantities. Characteristics of A.C. Circuit. Having Pure Resistance, Pure Inductance and Pure Capacitance

14. A. C. Circuits

- 8.1 A.C. Ckt. Having R, L & C in series, Power Factor, and P. F. improvement methods, Advantages/ Disadvantages.
- 8.2 A.C. Ckt. Having R, L & C in parallel, Vector & Admittance method. Series & Parallel Circuit and Its Characteristics.A.C. Bridges,
- 8.3 Poly-Phase Circuit. Generation & Phase Sequence Star / Delta Connection & its Characteristics. Power in 3 Ph. System for Balance & Unbalance load.

15. Electrical Measuring Instruments & Measurements

- 9.1 Absolute & Secondary Instruments. Principles of Operation of Instruments. Types of Torques for Instruments.
- 9.2 Classification of meters. M.I. meters, M.C. meters, Wattmeters Types, Explanation, Applications.
- 9.3 Energy meters- Types, Construction, Working, Errors in Energymeters, Applications. Digital Meters- Study, Advantages/ Disadvantages. Multimeters- Analog / Digital, merits- demerits.
- 9.4 Instrument Transformers- CT, PT, Characteristics, Applications, Testing Clip-On meter- construction, working, Megger, Earth Tester-Construction, Working & Applications.

Practical Contents :

Engg. Material -

- 01 To study the Construction of various types Cable
 - 1.1 Construction of LT cable.
 - 1.2 Construction of HT cable.
- 02 To study the various types of insulation material class wise
- 03 To find out the break down voltage of given transformer oil sample
 - 3.1 To collect various samples of insulating oil.
 - 3.2 To test the die elect. strength of samples.
- 04 To study LT & HT overhead lines insulator
- 05 To study characteristics of various types of special Resistive material
 - 5.1 To study Temperature sensitive resistive material.
 - 5.2 To study Light sensitive resistive material.
- 06 To study negative resistance characteristic of semi conductors
- 07 Collect any various magnetic materials e.g. Ferrite Core of Transformer & study.
- 08 Study characteristics of various types of thermocouple & its material
- 09 Study characteristics of Fuse material.
- 10 To prepare a chart of various types of batteries and troubleshooting
- 11 To study the Lead acid Battery material
- 12 To study related Indian Standard with Tech. Specifications, from related Web-sites of various engineering materials.

Electricity and Measurement

- 1 To Prepare a sheet of Atomic Structure.
- 2 To measure the Potential Diff. of a charged line.
- 3 To determine the Resistivity of a given material.
 - 3.1 To measure the length of given wire.
 - 3.2 To measure the diameter of wire & calculate cross section area
 - 3.3 To measure the resistance of wire by ohmmeter/multi meter.
- 4 To measure the Internal Resistance of a Cell by Potentiometer.
 - 4.1 To study the concept of internal resistance
 - 4.2 To make connections as per ckt. diagram.
 - 4.3 To calculate the internal resis. by using formula.
- 5 To Verify the characteristics of Kirchhoff's Laws.
 - 5.1 To verify Kirchhoff's voltage and current law
 - 5.2 To verify Thevenins, Nortons and Superposition's.
- 6 To Verify the Faraday's Laws of Electrolysis & determine the E.C.E. of copper.
 - 6.1 To understanding the process of electrolysis.
 - 6.2 To know the concept of metal deposition through electricity passing
- 7 To determine the Joule's constant by electric method.
 - 7.1 To understand the relations between current passing & heat generated.
 - 7.2 To calculate the Joule's constant by formula.
- 8 To Verify the Fleming's Left hand Rule.
 - 8.1 To find out the direction of mag. field around conductor.
 - 8.2 To observe the direction of torque of conductor.
- 9 To verify the Faraday's Laws of Electromag. Induction.
 - 9.1 To verify the Faraday's 1st law of elect. mag. induction.
 - 9.2 To verify the Faraday's 2nd law of elect. mag. induction.

- 10 To trace out the sine wave of A.C. on C.R.O. & find out the various values of A.C. quantities.
 - 10.1 To trace & measure the Peak value of A.C. sine wave.
 - 10.2 To calculate the R.M.S. & Average value.
- 11 Verification of Improvement of P. F. by using Capacitors.
- 12 To verify the characteristics of Star & Delta connections.
 - 12.1 To verify the characteristics of star connection.
 - 12.2 To verify the characteristics of delta connection.
- 13 To measure the power of 3 ph. balance & unbalance load using two-wattmeter method & calculate the P.F. of load.
 - 13.1 To measure the power of 3 ph balance load
 - 13.2 To measure the power of 3 ph unbalance load
 - 13.3 To calculate the P.F. of load using formula.
- 14 To calibrate the given 1 ph. Energy meter.

Title of Book Author Publication

- A Text Book of Electrical Technology. Vol.-I B. L. Thereja, A. K. Thereja. S. Chand & Company Ltd, New Delhi.
- Applied Physics B. G. Bhandarkar. Vrinda Publications.
- Basic Electricity & Electronics-I S. K. Patel.A. D. Maydeo. Nirali Prakashan.
- Electrical Measurements & Measuring Instruments. E. W. Golding. F. C. Widdis. Wheeler Publishing, Allahabad.
- Basic Electrical Engineering, Volume –I P. S. Dhogal. Tata McGraw-Hill.
- Electrical Engineering Measurements A K Sawhny S Chand & Company Ltd,
- 1 Basic Electrical Engineering M. L. Anvani
 - 2 Modern Electrical Engineer, volume-1 W. J. John
 - 3 Electrical Engineering materials A. J. Dekker
 - 4 Electrical Engineering materials Uppal / Arrora
 - 5 Electrical Engineering materials Indulkar
 - 6 Electrical Engineering materials Manchand

List of Tools & Equipments :

- 1 Plier Insulated combination 150 mm. -5
 - 2 Long Nose Insulated Plier 150 mm -5
 - 3 Punch Centre 150 mm x 9 mm.- 5
 - 4 Wire Stripper 150mm- 5
 - 5 Tweezer 100 mm Insulated -5
 - 6 Neon Tester -5
 - 7 Heat sink Plier -5
 - 8 I.C. Tweezer / Puller -5
 - 9 Screw Driver Set of 6 Nos. -5
 - 10 Watch Maker Screw Driver -5
 - 11 Adjustable Spanner / Slide Wrench (15 to 20 cis) -5
 - 12 Electrician Screw Driver 250 mm thin Stem Insulated -5
 - 13 Plier Side Cutting 150 mm -5
 - 14 Allen Key set -5
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1. 1 sq. mm PVC Copper flexible wire
 2. Electric lamps 100 watt, 250 v.
 3. Capacitors 400 v. assorted
 4. Bare copper,allu, nichrome wire
 5. Battery 6 volt
 6. Testing Board
 7. Assorted wires & cables
 8. Latest Primary cells
 9. Secondary Battery (Tubular plates)
 10. Allu. soldering material & flux
 11. Pin type Insulator Porcelain
 12. Threaded Pin G.I
 13. G.I.wire 10SWG
 14. Sand Paper 0 Nos.
 15. Cotton Waste
 16. Neutral link
 17. PVC Insulted single strand Aluminum cable 1.5 mm² ,250V grade
 18. Flexible PVC insulated cable 14/0.2 250V grade
 19. Bare copper wire 8SWG
 20. Fuse wire 1,2,5,10,&25AMP
 21. Insulation tape 20mm width 10m Coil
 22. Tube light Choke 40W,240V
 23. Copper Sleeves for 16mm² Cable
 24. Copper Ferrule for 16mm² Cable
 25. Copper Lug for 16 mm² Cable
 26. Solder flux 25gm tin
 27. Alca P Solder
 28. Bearing Grease Shell Alrania or equivalent
 29. Machine Screw 30mm long with nut & 2 Washers 25 nos
 30. Emery Sheet No."00" 05 Sheet

Subject Code: 30140019

Subject Name : Basic Electronics

1. Semiconductors

- 1.1 Intrinsic and Extrinsic semiconductors
- 1.2 Electrons and holes in an intrinsic semiconductor
- 1.3 Donor and acceptor impurities
- 1.4 Diffusion
- 1.5 Effect of temperature on intrinsic and extrinsic semiconductors.

2. Semiconductors diode characteristics

- 2.1 Open circuited p.n. junction as a diode
- 2.2 Current components in P.N. diode
- 2.3 V.I. characteristics and its temperature dependence
- 2.4 Diode resistance
- 2.5 Load line concept
- 2.6 Diffusion capacitance
- 2.7 Diode Switching time
- 2.8 Junction diode data sheet
- 2.9 Zener diode
- 2.10 Schottkey diode
- 2.11 V.I. characteristics
- 2.12 Zener diode voltage regulator
- 2.13 Zener and schottkey diode data sheet

3. Rectifiers and Filters

- 3.1 Half wave rectifier
- 3.2 Full wave rectifier, Bridge rectifier
- 3.3 Ripple factor
- 3.4 Ratio of rectification

4. BJT

- 4.1 THE JUNCTION TRANSISTOR
- 4.2 Transistor current components
- 4.3 Transistor as an amplifier
- 4.4 Transistor configurations and characteristics
- 4.5 Graphical analysis of the C.E. configuration
- 4.6 Analysis of cut-off and saturation regions
- 4.7 Typical transistor junction voltages
- 4.8 Transistor switching times and ratings Transistor as a switch.

5. Frequency Response of Bjt Amplifiers

- 5.1 Single stage C.E. amplifier and its frequency response
- 5.2 Effect of coupling and emitter bypass capacitors on low frequency response

6. MULTISTAGE AMPLIFIERS

- 6.1 Classification of amplifiers.
- 6.2 Decibel of Power Amplifier
- 6.3 Types of coupled Amplifier.
- 6.4 Direct coupled Amplifier.
- 6.5 R.C. coupled and transformer coupled amplifiers and their frequency response
- 6.6 Effect of cascading on Bandwidth and gain 10 03

7. MEASUREMENT TECHNIQUES & MEASURING INSTRUMENTS

- 7.1 Definition of measurement and instrument
- 7.2 Accuracy error, Range, Types of errors in measurement and Remedial methods
- 7.3 Merits and demerits.
- 7.4 Measurement of A.f. and R.F.

8 DIGITAL TECHNIQUES, BASIC LOGIC GATES, UNIVERSAL GATES

- 8.1 Binary, Decimal, Octal, Hexadecimal,
- 8.2 concept and design using AND, OR, NOT, NAND, NOR Verifying & study the truth table.
- 8.3 Boolean Algebra.

9 ARITHMETIC ELEMENTS

- 9.1 Half adder, full adder, Half subtract or, Full subtract or
- 9.2 1's complement, 2's complement
- 9.3 BCD adder.
- 9.4 Design of circuits using universal gates
- 9.5 Decoders, Encoders, Multiplexers, Demultiplexers
- 9.6 Flip Flops - R-S, J-K, Master slave f.f, and D types, Counters, synchronous and asynchronous Basic concept and Design using excitation table of flip flops e.g. binary, BCD.

Practical

1. Study of dual channel CRO

- 1.1 To Study the Front panel control of CRO,operation /application.
- 1.2 To study voltage measurement of AC/DC on CRO.
- 1.3 To study phase angle measurement on CRO.
- 1.4 To study component testing on CRO.

2. Diode (Ge, Si) characteristics and effect of temperature.

- 2.1 Testing of (Ge, Si) using DM.
- 2.2 Diode (Ge, Si) forward/reverse characteristics
- 2.3 Diode clipping circuits, clamping circuits

3. Zener diode characteristics and effect of voltage

- 3.1 Study of H.W.R./ F.W.R. with /without filter
- 3.2 Study of zener voltage regulator

4. **Bjt Operating Point And Load Lines, Effect of Temperature**
 - 4.1 I/P and O/P characteristics of C.B. configuration
 - 4.2 I/P and O/P characteristics of C.E. configuration
 - 4.3 To study the frequency response of single stage C.E. Amplifier
 - 4.4 To study the frequency response of single stage C.B. Amplifier
5. **To study the frequency response of two single stage R.C. coupled Amplifier**
 - 5.1 To study frequency response of C.E RC coupled Amplifier
 - 5.2 To study the coupling, bandwidth & frequency response.
 - 5.3 To study the different type of coupling, Direct & Transformer Coupling
6. **Operational Amplifier**
 - 6.1 Introduction to the Operational Amplifier ,
 - 6.2 construction and working of Operational Amplifier ,
 - 6.3 Schematic diagram of 741, symbol, Inverting and Non Inverting, Voltage amplifier, Linear and Non linear application of 741, Comparator using 741
 - 6.4 Summing amplifier and other popular op-amp
7. **Logic Gate**
 - 7.1 To study the Basic Logic gate & verifying its Truth table.
 - 7.2 Study of NAND/NOR as universal gates, Full adder using basic Gates & using NAND gates only,
 - 7.3 Design of combinational circuit
8. **Decoder, Multiplexer**
 - 8.1 Study of Decoder IC's,
 - 8.2 Study of Multiplexer IC's, study of 4 bit parallel adder, study of 4-bit comparator.
9. **Flip Flops**
 - 9.1 Study of Flip-flops.
 - 9.2 RS Flip flop, J-K Flip flop, D Flip flop.
 - 9.3 Master slave Flip flop
10. **Counter IC**
 - 10.1 Study of counter IC's, & its practical application.
 - 10.2 Study of synchronous counter, & its application
11. **Digital To Analog Converters**
 - 11.1 Study of D to A conversion.
 - 11.2 Study of A to D conversion
12. **IC Fabrications, Pcb Designing**
 - 12.1 Monolithic IC fabrication techniques
 - 12.2 Designing of Single ended Printed circuit Board.
 - 12.3 Designing of Double ended Printed circuit Board., glass epoxy.

Reference Books

- 1 Integrated electronics Millman And Halkias
- 2 Electronics devices and circuits Millman And Halkias
- 3 Microelectronics Jacop Millman
- 4 Electronics devices and circuits theory Robert Boylestad
- 5 Electronics devices and circuits theory Allen Mottershed
- 6 Basic electronics and linear circuits Bharagava
- 7 Electronic Measurement & Instrumentation B. Oliver & Cage.
- 8 Electronic instrumentation and Measurement Techniques W.D.Cooper
- 9 Digital Principles & Application Milavino & Leach
- 10 Digital Integrated Electronics Taub & Schilling

Subject Code: 30140020

Subject Name : Mechatronics

Theory	Practical
<p>History of Institute – necessary information, guidance to the new corner to get familiarize with the working institute, rules, procedures etc. Recreational, Medical & other facilities available in the institute. Importance of safety, accidents & Causes of Accidents . General Safety Precautions & personal safety to be observed while working in the institute /sections. Safe working habits, importance of good house keeping, cleanliness & orderliness & personal hygiene. Importance of the Trade in the industrial economy of the country. What is related instructions- subjects to be taught, achievement to be made etc.</p>	<p>Familiarization with institute & work place. Importance of the Trade Training, Types of the work done by the Trainee & role of “MEAHCNIE ADVANCED MACHINE TOOL MAINTENANCE” in an industry. Rules & regulations of the institute. Allocation of workplace. Issue of tool box & essential tools. Importance of Cleanliness & orderliness at the workplace.</p> <p>General Safety Rules. Introduction to First Aid practices- Method of Maintaining First Aid Box. Fire Fighting equipment & their uses. (Shop talk & demonstration). Familiarization with various hand tools used in the trade. Introduction to bench vice, its construction, operation, maintenance & Lubrication.</p>
<p>Introduction to measuring & checking instruments. Non-precision linear measurement by using steel rule, depth rule, hook rule & zigzag rule, bit rule, tape etc. Measurement by using firm joint caliper, spring joint caliper, adjustable bevel protractor & combination set etc. Measurement with precision instrument : Vernier calipers- principle & construction, reading a vernier caliper, care & maintenance etc. Vernier Bevel Protractor.</p>	<p>Preparation for filing. Gripping the job suitably in the Vice jaws for filing.</p> <p>Taking correct standing posture with respect to bench vice for filing. Balancing of File. Filing To the marked lines using rough file. Use of simple measuring instruments such as Steel Rule, Vernier caliper, inside/outside Micrometer. Care and precautions to be observed in handling these instruments. Measurement by using inside/outside calipers and scales. Exercises on measurement of various geometrical shapes. Exercise on making lines on the work piece according to simple blue prints, using marking tools such as steel rule, scribe, marking blocks & driver. Scribing lines on chalked or coloured (blue) surfaces of the work piece supported properly against the angle plate on marking off table to an accuracy of + or-0.5 mm. Marking location of the centers of circle by drawing horizontal & vertical line & then scribing circles using dividers. Use of Dot & Centre punch for punching the lines, centers & circles. Layout the dimensional features of the work piece using vernier height gauge, engineering Square, angle plate & surface plate.</p>

<p>Work bench, bench vice-constructural details, different types of vices, their uses, care and maintenance of vices.</p> <p>Files:- File parts & material classification of files based on grade, cut, shape, length etc. Printing of file, Convexity of file- reasons, reconditioning of files, file care & its uses. Methods for steady & accurate filing-no. of strokes per minute, right method of fixing file handle, care & maintenance of files.</p>	<p>Balancing of file using rough file to be continued on channel. Filing flanges of a channel for practicing of filing. Filing flat surface & flanges of a channel maintaining parallelism between them using outside calipers within + or -0.5mm</p>
<p>Introduction to layout marking, making media & marking tools-construction, use, care and maintenance. Procedure of marking. Types of marking operations. Equipment and instruments :- Construction, use, care & maintenance of surface plate, marking table, scribe, dividers, surface gauges, angular plate, marking block, V block & clamp. Hermaphrodite caliper. Engineering square, parallel block, "C" clamp, tool makers clamp, combination set, bevel square etc. Introduction to punches, material, uses and care of various types of punches such as center punch, dot punch etc. Letter & number punch set. Pin & Hollow punches. Hammer parts, types, specification & uses of hammers. Fitting the handle to the hammer head , precautions/care & maintenance.</p> <p>Types of hacksaw frames special frames. Different parts. Types of Hacksaw blades material, specification & uses. Reasons for breaking of Hacksaw blades. Care & maintenance, points to be observed while hack sawing to avoid breakage blades. Safety to be observed while hacks awing.</p>	<p>Exercise on filing the adjoining outside faces of flanges of channel square to flat surface of channel as reference surface.</p> <p>Filing faces of channel for maintaining</p> <p>a. Flatness & square ness of adjacent faces using tri-square b. Parallelism between opposite sides. Filing with second cut file to prepare smooth surface.</p> <p>Exercises for filing practice to develop control on hand and feel for maintaining dimensions within + or- 0.1 mm using Vernier Caliper. Filing with second cut files to prepare smooth surfaces.</p>
<p>Types of Chisels-material, specification & application. Hot Chisels & Cold Chisels. Different cutting angles & their mportance. Method of Chipping & safety precautions to be observed while Chipping. Use of proper Hammer. Grinding-Sharpening of Chisel on bench grinding machine.</p>	<p>Marking of profiles-combination of straight lines, circles, arcs & angles. Use of scale, divider, vernier height gauge, protractor, combination set etc. for marking profiles. Marking on the job piece for saw cuts. Gripping the job suitably in the vice jaws for hack sawing to dimension. Hack sawing various metallic pieces (Mild Steel, Aluminium, Copper, Brass, Stainless Steel etc.) of different thickness and cross sections (round, square, angles, flats etc.) using hacksaw blades of different TPI's within dimensional accuracy of + or - 0.5 mm.</p>

	<p>Hack sawing different lengths with hacksaw frame in horizontal & vertical positions. Sawing along the parallel marked lines within 0.5 mm allowance for filing. Hack sawing steps and slots. Finishing hack saw cut pieces by filing for step & slot fitting. Cutting of sheet metal with chisel.</p>
<p>Types of Drills –nm Flat & Twist Drills, straight fluted & special types of drills, parallel & taper shank drills construction /material & use. Nomenclature of flat & twist Drill- specification of Drill, Drill angles & their importance, advantages & disadvantages of flat & Twist Drills. Drill Grinding- sharpening of Drills, Web thinning – checking and round drill, common faults- mistakes & their ill-effects. Cutting speed & feed- setting/selection for various operations. Counter boring, spot facing & counter sinking operations of Drilling machine. Cutting fields (Coolants) used in drilling.</p>	<p>Hammering practice on vertically held round job. Blind hammering practice .Stamping Letters & Numbers on M.S. plates. Exercise on stamping to develop judgement, control on hand & feel. Stamping practice on flat & round surfaces. Use of cross Peen Hammer for stretching of metal strip. Use of flat, cross cut & Round Nose chisels for chipping of edges & cutting grooves. Using cross cut chisel for cutting key way on round bar.</p>
<p>Introduction to drilling machine – Portable & Hand Drilling Machine. Bench and Pillar-Upright type drilling machine. Study of drill holding devices. Drill chuck, chuck key, drill drift, sockets & sleeves-construction, material & use. Method of drives, sizes, capacity & specification of a drilling machine. Special features, care & maintenance of drilling machine. Safety precautions to be observed while working on a drilling machine. Speed changing system, use of simple gear boxes, feed for drilling. Standard speed & feed for various material, various methods for job holding on drilling machine table. Drilling defects & their causes.</p>	<p>Introduction to Drills. Preparations for drilling. Marking out the position of holes & Dot punching. Deepening the points with center punch. Checking for center distance. Drilling practice on sensitive drilling machine using different types of drills & drill holding devices. Safety to be observed while working on drilling machine. Marking, Chain drilling & filing to produce square, round & triangular openings on 6 mm thick plate. Preparing inserts by hack sawing & filing. Fitting inserts in the respective openings exercise on step & angular fitting.</p>
<p>Introduction to reamers, types of reamers, pitch of flute, precautions to be observed while reaming. Allowances for reaming, coolant used while reaming. Floating holders for reamers. Construction & use of Hand Reamers, expansion reamers, adjustable reamers, taper reamers, rose reamers, chucking reamers etc. Elements & forms of screw threads. Single and multi-start threads, right & left hand threads. Hand and machine taps, sizes, tapping on different types of materials, Lubricants for tapping- tapping blind holes. Reasons for breakage of taps & removal of broken taps. Tap Wrenches, construction, standard dimensions.</p>	<p>Drilling practice on varying thickness & different materials such as Mild Steel, cast Iron, Stainless Steel, Copper, Brass, Nylon, Epoxy etc. Epoxy etc. Drilling on sheet metal. Precautions & safety to be observed. Counter sinking, counter boring & spot facing operations using bench drilling machine. Exercises on Reaming with hand reamers & machine reamers. Internal threading by hand using Tap Sets. External threading by split die & finishing of thread by Die nut. Marking centers on two and end faces of a round bar with the help of “V” block & clamp.</p>

<p>Determination of sizes of drill for tapping standard holes. Cutting internal threads, tapping blind holes. Types of dies, solid and split dies, die stocks & handles. Methods of thread cutting with die & die stock. Setting the threading die. Use of lubricants. Use of hand chasers & machine chasers.</p>	<p>Drilling & Reaming of blind holes along the axis of round jobs. Grinding of drills & chisels to specifications & checking of angles with gauges.</p>
<p>Elements of interchangeable system. Definition of Limit, Tolerance & Allowance. Basic dimensions or sizes. How Limit & Tolerance is denoted ? Application of tolerance. Tolerance of Form & Position. Use of symbols. System of Tolerance & Limits, ISI System. BIS System Terminologies used in practice and their definitions such as size, nominal size, basic size, actual size, limit of size, deviations (upper , lower, fundamental), zero line, tolerances, tolerance zone etc. Examples of fixing limits for various types of Fits commonly met with machine in relation with clearance & interference Component assembly such as, Free Fit Med. Fit Snug fit, Wringing fit, Tight fit, Medium force fit, Shrinkage fit etc. Interchangeability & standardization, method of selective assembly, hole & shaft basis of system. Micrometer- inside & outside – constructional features, Principle operation, graduations, reading – use, care & maintenance Purpose, types, construction, function and method to use comparators.</p>	<p>Exercise on filing – Radius & Angular filing using templates & gauges. Filing Templates & gauges for checking. Lathe tool angles. Filing to an accuracy of + or – 0.1 mm., checking with Vernier Caliper. Preparation of plates for gauge fitting. Filing of various angles & clearances of lathe tools on square blanks. Checking with templates & Gauges already prepared. Measurement of shaft & hole diameters using outside & inside micrometer. Filing round on square bar within + or –0.1 mm.</p>
<p>Types of spanners-their material & uses-Box, Socket, Tubular, hook spanner etc. Wrenches – material & use of T Socket, Monkey, Ratchet, Pipe wrenches etc. Types of screw drivers- materials & uses. Types of Pliers- Material & uses, combination pliers, Long nose pliers, flat nose pliers circlip pliers etc. Fasteners & classification of fasteners. Permanent; Semi-permanent and temporary fastening devices, locking devices. Thread fasteners. Nut: Types of nuts- hexagonal nut, square nut, lock nut, check nut, castle nut, flanged nut, cap nut dome nut, slotted nut, serrated nut etc. and their functions. Bolts: Types –hex head, square head, round head, cheese head bolts, eye bolt, stud bolt. Screws: Set screw, machine screw, Philip head screw, sheet metal screw, wood screw etc. and their functions.</p>	<p>Use of Combination & Round Nose Pliers to make different shapes/profiles by bending wire to match the blue print to develop manipulative skills, hand control & eye judgment Using hand tools such as screw driver, single end/double end spanners, single end/double end ring spanners, box nut spanners, ratchet spanners, circlip pliers, wrenches, pullers, extractors, drift. Correct method to be used & care to be taken in using these tools. Cold riveting. Marking out location & drilling of holes for riveting. Use of dolly & snap for forming rivet heads. Lap & Butt Joint by cold riveting.</p>

<p>Washers: locking plates, spring washers, fiber washer, tab washer, rivets, studs, pins, keys etc. Merits & demerits with examples, advantages and disadvantages of using each one- where generally used and why? Keys & cotters – Classification & comparison of keys & cotters. Rivet and riveting – the object of riveting, the relation between the sizes of rivets and thickness of the sheets. Pitch of rivets. Rivet types, uses, method of riveting using snap and dolly. Riveted joints – likely mistakes while riveting and remedies</p>	
<p>Scraping- importance of scraping- advantages – different methods of scraping- scraping procedure for producing flat surfaces. Checking of scraped surfaces- use of spirit level. Tools required for scraping. Scrapers- different types & their correct use/application- use of surface plate, straight edge, angle plate, master cylinder in the process of scraping.</p>	<p>Project work: making parallel clamp “C” clamp or micro meter stand by using acquired skills.</p>
<p>Properties & uses of Ferrous and Non-ferrous metals and their alloys such as Cast Iron, Wrought Iron, Mild Steel, Carbon Steel, Tool Steel, High speed steel. Aluminium, Copper, Tin, Lead, Zinc, brass, Bronze, White metal, Rubber and Plastic. Methods of producing Cast Iron Steel. Study of physical, chemical and mechanical properties of materials and testing of materials. Plastic deformation of materials – Cold & Hot Bending- Bending- Bending of Strips. Change in mechanical properties of material in Hot & Cold Bending. Meaning of tenacity, elasticity, malleability, ductility, toughness etc. With special reference to practical application – use of various engineering materials.</p>	<p>Scraping on flat surface. Taking impression for high spots using Persian blue. Sharpening of scrapers using diamond wheel & lapping stone.</p>
<p>-do-</p>	<p>Scraping on flat surface. Taking impression for high spots using Persian blue. Sharpening of scrapers using diamond wheel & lapping stone.</p>
<p>-do-</p>	<p>Application and use of dial indicators, slip gauges and height gauge/height master. Application of various measuring instruments to measure of a component.</p>

<p>Familiarization with plastic deformation of material , Cold & Hot bending of strips. Commonly used pipes-sizes, material and specification . Use of pipe for Hydraulics/ Pneumatics & Lubricating system (Ferrous and non-ferrous) Bending of solid sections by using bending fixtures, bending dies etc. Cold and hot bending of pipes of different diameters of ferrous metal i.e. hydraulic pipes & Non-ferrous metal i.e. copper tubes for lubrication system. Pipe bending with or without filing in fine sand. Use of pipe bending fixture to maintain uniform bending radius. Precaution to avoid wrinkles. Pipe cutting using pipe cutter. Pipe threading & piping using various pipe fitting such as “T” fitting, elbow fitting, reducers etc. Punching of holes on leather with hollow punches. Preparation of gaskets & other packing materials.</p> <p>Standard pipe threads, cutting of pipe threads using Dies & taps. Care and precautions to be observed while using pipe vice, pipe wrenches, dies and taps.</p> <p>Standard pipe fittings- Methods of fitting & replacing the fittings. Methods of detecting leaks all the joints. House Hold piping- standard pipe fittings. Fullering practice & ferrule fitting.</p>	<p>Application of Advanced Bench Working Skills Practice on exercises involving making of simple machine parts which have certain functional relationship to other parts such as cam motion driving mechanism, dovetail by assembling parts using bolts, dowel pins, locking devices etc. Precision fitting jobs involving sliding, scraping & alignment.</p>
<p>Micro-meters- special types- important features & applications. e.g. Thread checking micrometer, flange Micrometer, Depth Micrometer etc. Sine bar, slip gauges- its principle of working & applications. Purpose and method to use similar & slip gauges and rollers.</p>	<p>Filing flats on cylindrical parts. Filing square at the end & in the middle of cylindrical rod within + or -0.04 mm.</p> <p>Introduction to lapping process. Laps & lapping pastes, procedure for charging lap. Use of kerosene in lapping. Lapping on flat & cylindrical (internal and external) surfaces.</p>
<p>Types of gauges- Plug , Ring, Snap, Taper, feeler, screw Pitch, Radius & sheet metal gauges. Dial indicators- construction & use. Various types. Comparators – Electrical, Optical pneumatic construction & working principles. Definition of surface finish. Terms used to describe the surface finish. Dimensional Tolerance of surface finish according to ISI. Surface quality & its symbolic representation. Equipment used for testing/measuring surface quality. Units of surface finish. Surface finishing processes, lapping, honing, electroplating, metal spraying, galvanizing, pickling and Metallisation.</p>	<p>Bending of solid sections by using bending fixtures, bending dies etc.</p> <p>Cold & Hot bending of pipes of different diameters of ferrous metal i.e. hydraulic pipes & non-ferrous metals i.e. copper tubes for lubrication system. Pipe bending with or without filling in fine sand. Use of pipe bending fixture to maintain uniform bending radius. Precautions to avoid wrinkles. Pipe threading & piping using various pipe fitting such as “T” fitting. Elbow fitting, reducers etc. Punching of holes on leather with hollow punches. Preparation of gaskets & other packing materials. Fullering practice & ferrule fitting.</p>

<p>Definition of lapping & its necessity. Constructional features of lapping. Design of laps-Cast Iron, Copper, Lead, Mild steel etc. Abrasive material and the form in which it is applied. Popular names of abrasive used. Simple examples, practical situations of lapping. Lapping methods & their applications. Testing of surface quality after lapping. The objective of honing- Honing-description of honing and its necessity – Honing methods and their use. Simple examples, situation where honing is used. Rotary & Longitudinal motion in honing Cylindrical object. The effect of Honing on the efficiency of running components. Honing tools-shape of abrasive- Grades. Honing allowance</p>	<p>Using hand tools such as screw driver, single end/double end spanners, single end/double end ring spanners, ratchet spanners, circlip pliers, wrenches, pullers, extractors, drift. Correct method to be used & care to be taken in using these tools. Marking out key ways of various shapes. Using cross cut chisel for cutting corners. Checking depth with depth gauge & fitting key ways. Making different types of keys & key ways on pulleys, gears etc. by hand.</p>
<p>Specification and use of different types of ropes such as hemp, manila, nylon, wire etc. Practicing different types of knots and its applications. Method of joining two ropes together foreextension. Detection of unsafe/ defective conditions of ropes and knots. Specification and correct use of slings. Safety to be observed in the use of ropes and slings.</p>	<p>Familiarization and use of different types of ropes such as hemp, manila, nylon, wire etc Familiarization and use of different types of ropes such as hemp, manila, nylon, wire etc.</p>
<p>Different types of appliances and tackles for shifting, loading and unloading of machine and equipment. Screw jacks- their use and working principles. Chain pulley blocks- their use and working principles. Crane and Hoist for lifting purpose – working principles & main constructional features. Working principles & use of other tackles like Crabs, winches, slings, rollers and bars, levers, lashings and packing. Mechanical advantage and velocity ratio. Use of inclined planes. Special precautions in handling heavy equipment, removal and replacement of heavy parts. Safety in transportation.</p>	<p>Familiarization and use of different types of ropes such as hemp, manila, nylon, wire etc.</p>
<p>-do-</p>	<p>Use of hoists and cranes for lifting purpose. Constructional features and working principles. Methods lifting jobs of various shapes, sizes and weights. Use of appropriate length of chains. Inspection of chain links.</p>

Revision & Test	
<p>Metal cutting and cutting tools. Introduction to metal cutting. Mechanism of metal cutting-orthogonal and oblique cutting, chip formation, types of chips and chip breakers. Cutting tool geometry and nomenclature, control of angles, tool life. Cutting speed and feed and its calculation. Properties and uses- cooling system types – soluble oils-soaps, paraffin, soda water etc. biodegradable oil. Effective of cutting fluids in metal cutting.</p>	<p>Constructional features and working principles of Lathe machine. Functional relationship of various parts of the machine. Study of the gear box and drives used on the machine. Study the methods of holding work piece and tool using different devices. Exercises on plain, stepped, taper and form turning, knurling etc. Exercises on drilling, reaming, boring counter boring etc. Screw thread cutting both external and internal of different types. Exercises on eccentric turning. Grinding of Lathe tools. Care and maintenance of machines. Safety precautions to be observed while handling machines. Study of lubrication system and preventive maintenance. Simple projects such as hollow punch, pulleys, gear blanks, simple couplings etc.</p>
<p>Constructional features, types, functions and use of Lathe machine. Study of Lathe accessories – face plate, chucks, steadies their use. Driving mechanism – Gear box mechanism gearing, common lathe tools-their names, materials and use, cutting tool angles, grinding of lathe tools. Common lathe operations- chucking, centering, plain turning, facing and boring,taper calculations –screw cutting. Cutting speed and feed, use of coolants. Care and maintenance- preventive maintenance.</p>	-do-
<p>Constructional features, function and use of shaping machine, working principle, use of Quick Return Mechanism. Setting of length and position of stroke. Holding of work piece & tools. Various cutting tools and tool angles for carrying out shaping operations. Speeds and Feeds. Use of coolant for different materials. Detection of common faults & their rectification.</p>	<p>Constructional features and working principles of shaping machine. Functional relationship of various parts of the machine. Study of Quick Return mechanism. Different work and tool holding devices. Flat and angular shaping. Groove cutting on shaping.</p>
<p>Constructional features and working principles, types, functions, use of milling machines, attachment and accessories. Different methods of holding work piece and cutters. Common milling operations such as plain, step, angular milling, slot and groove cutting, use of dividing head for indexing-types. Various types of gears and elements gears. Gear cutting and Cam cutting. Various speed and feed. Use of coolant for different materials.</p>	<p>Constructional features and working principles of Milling Machine. Functional relationship of various parts of the machines. Study of gear box and drive used on the machine. Study of different work and tool holding devices. Exercises on parallel and angular milling. Exercises on grooving using end mills. Cutting of gears-spur and helical using simple indexing. Use of slotting attachment for cutting keyways.</p>

<p>Detection of common faults-detects and their rectification. Safety precautions. Care and maintenance-preventive maintenance of milling machines.</p>	<p>Care and maintenance of machine. Safety precautions in handling machine. Study of lubrication system and preventive maintenance. Simple project such as jaw, claw, Oldham coupling, spline cutting etc.</p>
<p>Constructional features, types, functions and use of grinding machines. Grinding wheels and their specifications-grit, grain size, structure, bond, grades etc. Use of grinding wheels, balancing and truing. Dressing of grinding wheels, holding of work piece. Various grinding operations-external, internal, surface grinding. Common defects-faults their detection and rectification. Use of coolants for grinding different materials. Safety precautions to be observed in grinding operations. Care and maintenance-preventive maintenance of grinding machines.</p>	<p>Constructional features and working principles of surface and cylindrical grinding machines. Functional relationship of various parts of the machine. Study of drive-both mechanical and hydraulic. Study of different work holding devices. Grinding wheel specifications. Mounting, balancing, turning and dressing of grinding wheels. Exercises on surface grinding-parallel and angular, step and groove grinding. Exercises on external and internal cylindrical grinding-both plain and taper. Study of hydraulic systems used on the machine. Care and maintenance of machine. Safety precautions to be observed while using machine. Study of lubricating system and preventive maintenance.</p>
<p>Commonly used sheet metals-rolled sheets such as tin, galvanized iron, copper, brass, aluminium sheets-their physical properties and uses. Common tools used for sheet metal-Tina man, mallets, stakes, swages, shears, snips, stripes, scribes, trammels, dividers etc. Simple developments and method of laying out. Types of joints-folded joint, grooved and beads etc. Soldering, sweating, brazing and tinning materials and method employed. Soft and hard solder-their composition, properties and use. Types of joints-folded joint, grooved and beads etc.</p>	<p>Practice in drawing simple geometric shapes on sheet metal using marking tools. Practice in cutting sheet metal in these shapes and cutting sheets to various angles using hand shear, snip and chisel. Bending sheet metal to 90° using wooden mallet, clamp etc. on a bench vice. Practice on lap joint, lock grooved joints and hammering. Cutting practice with different snips, cutting of notches, inside and outside curves. Sheet metal cutting on shearing machine. Safety in operations. Forming rectangular, round and conical shapes using stakes. Removal of dents and simple hollowing practice. Use of hard and soft solder. Soldering practice on ferrous and non-ferrous metals. Practice in riveting sheet metals of various thicknesses. Exercise using pop rivets. Simple development work. Practice in marking simple articles such as, machine guards, shovels and trays, funnels, taper bins etc.</p>

<p>Inspection, quality control, quality assurance, total quality management concepts and quality awareness. Zero defect, self inspection and applications.</p> <p>Statistical process control:-</p> <ol style="list-style-type: none"> a) control charts b) chance causes and assignable causes c) plotting of control chart d) various type of trends. 	<p>Application and use of dial indicators, slip gauges, height master and various measuring instruments (such as inside caliper, dial bore gauges, three leg micrometer, dial micrometer and comparator) to measure internal and external features of the component.</p> <p>Measurement of co-ordinates, center distance, angle, centricity, eccentricity, dovetail slot etc. by using :-</p> <ol style="list-style-type: none"> i) Lever type dial indicator and slip gauge. ii) Liver type indicator and height master. iii) Dial indicator and rollers and pins. iv) Turning the job with the help of screw jacks(for casting, forging etc.) <p>Practical exercise for thorough understanding of statistical processes control concept. Construction and use of various control charts. Detection of chance and assignable causes and study of various trends.</p>
<p>Gas and electric welding – tools and equipment.Principle of fusion welding. Types of joints and method of welding. Safety precaution and maintenance of equipment. Welding defects – causes and how to avoid them. Flame cutting – principle and use of equipment.</p>	<p>Working principles of Arc, gas and spot welding machines. Connecting and setting of machine for operation. Safety to be observed in welding work. Practice in simple arc welding using materials of different thickness. Horizontal and vertical position welding. Practice on butt and lap joints. Practice in brazing of ferrous and non-ferrous metals, silver brazing, braze welding(dissimilar metals).</p> <p>Study of welding defects (arc and gas) and precaution to avoid them. Practice in metal deposition for joining of cranks, repairing of worm out parts, key ways, keys, broken gears, teeth, filling and padding on shafts. Practice in flame cutting. Care and maintenance of welding equipment.</p>
<p>Modern theory of atomic structure in general – nucleus, orbits and free electron, orbital electron, valance electron – free electron. Classification of materials as conductors and insulators, semiconductors and resistors. Concept of electromotive force, voltage current and resistance. Electrical safety rules and precautions. Ohm’s Law and Kirchoffs voltage and current law. Types of circuits – series, parallel and series – parallel. Electrical work, power and energy – definitions and units of measurement and</p>	<p>Safety precautions applicable to electrical trade. Grinding of wire as per ISI and cables, colour coding used on them. Removal of insulation of wires/cables and soldering free ends of copper strands. Joining of flexible cables by soldering staggered joints in case of twin wires or multicore cables. Familiarization with different types of plugs, sockets, switches, fuses and fuse holders, cut outs etc. with their specifications and applications.</p>

<p>their inter relationship. Primary sources of electromotive force/electrical energy. Primary and Secondary cells. Introduction to electrical supply system with special reference to AC. Different voltages in use AC and DC. Types main switches, circuits breaks, fuses etc. effects of electric current in general.</p>	<p>Testing of switches, buttons, limit switches, micro switches by using continuity tester for their operation. Identification of live, neutral and earthing wires before connecting cable to plugs, sockets, switches, cut outs etc. Use of test lamp and multi-meter for identifying single phase/three phase power supply. Use of multi-meter for voltage, current and resistance measurement. Checking of DC supply. Use of voltmeter and ammeter for voltage and current measurement respectively. Connecting portable single phase AC operated industrial equipment such as drilling machine and domestic applications such as washing machines, cooking range, geyser etc. Practice of series and parallel connection of loads and measurement of voltage drops across the loads and line current. Practice of logic development for control. Constructing logic gate circuits such as AND, OR, NOR etc. by using series and parallel combinations of switches to control the condition of load lamp(ON or OFF) – condition of out put lamp indicating out put conditions in truth table. Wiring of simple electrical circuits (to understand the concept of control) on test boards such as single point, series parallel, master, staircase, godown, control of lamps. Wiring and testing of fluorescent lamp fitting. Function of chock and starter in its operation. Care and maintenance of batteries – charging of batteries. Series and parallel connection of batteries.</p>
<p>Semi-conductor theory. Intrinsic and extrinsic semi-conductors. P and N type semiconductors and P-N junction – semiconductor diode – two layer and two terminal device. Use of PN junction as switch. Use of PN junction for rectification. Half wave, full wave and bridge rectifiers. P-N-P and N-P-N junction devices –transistor – three layer three terminal devices. Use of transistor of a switch and its simple applications. Use of transistor for amplification – how amplification takes place. Soldering technique as applied to PCB soldering DO's and Don'ts.</p>	<p>Scope of industrial electronics with reference to its applications in machine tool operation. Identification of basic components such as registers, capacitor, inductors etc. from their out look. Types, specifications and general applications of these components. Testing and measurement of their values using multi-meter. Use of resistance colour codes. Soldering and desoldering of component on and from printed circuit boards (P.C.B.). Precautions to be taken while soldering on PCB. Study of rectifiers circuits – half wave, full wave and bridge rectifiers.</p>

	Use of oscilloscope for checking of input and output wave forms. Study of solid state devices such as diodes, transistors, SCRs and Ics available in different packages. Types and applications. Identification of leads and testing by multi-meters. Assembly of simple battery eliminator circuit using bridge rectifier and filter capacitor. Measurement of input and output voltages.
Revision & Test	
Industrial hydraulics – principles, advantages, disadvantages and safety. Study of block diagram of hydraulic system in general. Construction features, principles of operation, function and uses of various hydraulic components such as pumps, valves, actuators and power pack. Hydraulics fluids – specifications, properties and applications. Study of hydraulic power pack and its control elements. Familiarization with various symbols used in hydraulic circuit diagram. Identification of components and their specifications. Hydraulic circuit reading and tracing practice. Circuit drawing practice using symbols. Constructing simple hydraulic circuit for linear /rotary/motions and testing for operation. Constructing simple hydraulic circuit for speed control both linear and rotational and testing for operation and troubleshooting.	Industrial hydraulics – principles, advantages, disadvantages and safety. Study of block diagram of hydraulic system in general. Construction features, principles of operation, function and uses of various hydraulic components such as pumps, valves, actuates and power pack. Hydraulics fluids – specifications, properties and applications. Study of hydraulic power pack and its control elements. Familiarization with various symbols used in hydraulic circuit diagram. Identification of components and their specifications. Hydraulic circuit reading and tracing practice. Circuit drawing practice using symbols. Constructing simple hydraulic circuit for linear /rotary/motions and testing for operation. Constructing simple hydraulic circuit for speed control both linear and rotational and testing for operation and troubleshooting.
Construction features, principles of operations and uses of pneumatic components such as valves and their actuators. Identification of components from their outlook and their specifications. Pneumatic circuit reading (from manuals) and circuit tracing practice. Circuit drawing practice using symbols for simple application. Constructing simple pneumatics circuits for linear reciprocating and rotary motion. Testing for operation and troubleshooting.	Construction features, principles of operations and uses of pneumatic components such as valves and their actuators. Identification of components from their outlook and their specifications. Pneumatic circuit reading (from manuals) and circuit tracing practice. Circuit drawing practice using symbols for simple application. Constructing simple pneumatics circuits for linear reciprocating and rotary motion. Testing for operation and troubleshooting.

<p>Methods employed for installation and erection of precision and heavy duty machines. Location and excavation of foundation. Different types of foundations – structural, reinforced, wooden, isolated foundations. Foundation for heavy machines such as presses /hammers etc. Foundation for precision machines – special precautions necessary for erecting precision machines. Importance of isolated foundation. Special process involving in erection of heavy duty machines. Layout of machines – consideration of power, space, weight, ventilation and moving parts etc. Types of vibrators, causes and prevention of vibrations. Methods of insulation of machines of machines against vibration. Anti-vibration devices and their locations. Different types of instruments used for checking the vibrations. Leveling machines, importance of leveling. Methods of grouting. Use of machine leveling screws. Methods of leveling, precautions to be taken while leveling, leveling accuracy – its measurement. Special precautions necessary for precision machines. Use of spirit level, its construction and use. Use of camel back, straight edges and slip gauges for leveling.</p>	<p>Introduction to leveling of machines. Practice on leveling – use of spirit level, camel back, straight edge, bridge, parallel blocks etc. Leveling of surface plates, marking table, milling machine, grinding machine etc. – precaution of test report indicating degree of flatness. Use of leveling bolts, taper wedges for leveling of horizontal and vertical surfaces. Introduction to machine alignment. Checking lathe, milling, grinding machines for alignment and preparing test reports comparing with standard test charts.</p>
<p>Machine alignment – different types- procedure. Equipment for aligning machine-use of test mandrel, master cylinder, straight edge, centricities, slip gauges, dial indicators etc. Precautions to be observed in the use of equipment while aligning. Special precautions necessary for erection, leveling and aligning precision machines. Testing for correct functioning of machine parts, machine commissioning.</p>	<p>Study for various spindle drive mechanism used on bench grinder, drilling, milling, lathe and grinding machines. Checking for spindle run-out – axial and radial play. Setting of play as per standard chart. Checking of bearings for its performance – repairs and replacement as needed. Study of shafts, axels, couplings and clutches used on various machines. Locating and identifying these elements on various machines. Dismantling clutch mechanisms. Study of standard machine elements. Cleaning and inspection of parts for any damages/wear out etc. and carrying repairs of replacement. Assembly and oiling of clutches and fitting back to its location. Testing for operation. Preparation of reports.</p>

<p>Prime movers. Types of drives-Rope & Chain. Variable speed transmission PIV drives and Harmonic drives. Friction drives. Clutches positives clutches, friction clutches. Mechanical, Hydraulic and Pneumatic drives-basic principles and uses. Individual drive and group drive. Care and Maintenance of different types of drives and their applications. Study of individual drive system, reciprocating, reverse, eccentric, cams, cranks drives. Rotary to linear drives and viceversa.</p> <p>Power transmission elements. Shafting shaft, types of shafts-rigid and flexible and hollow.</p>	<p>Study of Belt Pulley, Chain, Gear, Rack & Pinion etc. used on different machines. Introduction to various gear transmission mechanisms. Removing gear box from various machines and opening for inspection and study of gear trains and their functional relationship. Dismantling of gear box completely. Study of various machine elements from the gear box. Cleaning and checking/inspection of parts for damage /repairs. Assembly of gear box and fitting back to the machine. Testing and preparation of report.</p>
<p>Types of pulleys solid, split, “V” groove, step, cone, taper, guided and jockey or rider pulleys etc. their functions and uses. Specifications and selection of pulleys for specific applications. Necessary calculations for deciding to size diameter, width, weight etc. consideration of drive to driven ratio. Crowning of pulleys. Fast and loose pulleys.</p>	<p>-do--</p>
<p>The object of belts types /sizes/ specifications and uses. Materials used for belts-leather, cotton, canvas, Indian rubber (Batala). Selection of the type of the belt with the consideration of load and tension. Leather belts-methods of joining the Ends /bolting leather belt and their specific advantages. Belt Fasteners-different types, advantages & disadvantages of each other.</p>	<p>Inspection of machine guide ways and slides. Checking for straightness, flatness, scoring/scuffing marks and condition of oil grooves and wear. Adjustment of Gibs, wedges for setting the gap. Use of Feeler gauges and dial indicator. Study of feed Mechanism- Removing, dismantling, cleaning and oiling of its machine elements assembly and fitting back to its position. Testing for its operation. Mechanism to be studied- -Lathe machine-carriage, apron, feed box, head stock etc. -Milling machine Feed box(column, knee, saddle,) rapid traverse gear box, intermediate gear box etc.</p>
<p>Types of belt drives, velocity ratio of belt drive. Horse Power transmitted by belt. Ratio & driving tension in a belt. Parallel & cross belt drive, open & cross belt drive, angular belt drive. Geometrical explanation of the belt drives at an angle. Belt speed used for commercial belts. Calculation for the size of the new belt. Slipping of the belts-causes & remedies. Use of guide pulleys, crowing, use of dressing and resin power to avoid creep and slipping. Use of chains, wire rope for power transmission. Methods of fixing and uses. Types brief description. Types rigid</p>	<p>Familiarization with plain/journal bearings, anti-friction bearings used on machine assembly. Specification & selection for appropriate use. Use of manufacturers catalogues. Mounting of bearing on shafts and in housing with proper fit & axis alignment. Use of proper tools. Removal of bearings from shafts & housing by using pullers. Cleaning up & removing old metal form bearing and replacing with new metal. Scrap & fit bearings to a shaft. Fitting shaft to main line bearings. Cut oil grooves in</p>

<p>coupling-Flange coupling. Hook's coupling, Universal coupling, Flexible couplings their different uses. Friction and Universal coupling advantages and disadvantages over each other & their applications. Types and uses, their function and application. Pre-requisites of a key prevention of circular /longitudinal motion of machine parts. Types of key and key ways, their uses and applications. Preparation of keys, allowable tolerance, clearances. Key fitting procedure-methods. Procedure for removing keys. Types & uses of key pullers. Use of keys in power transmission.</p>	<p>bearings. Checking of shafts for alignment with dial indicator, practice in scraping flat bearing surfaces.</p>
<p>Types-materials and uses of gears. Various manufacturing processes. Study of spur gear elements-tooth profile-pitch circle-diametric pitch velocity ratio of a spur gear. Helical, Herring bone, Bevel, Spiral Bevel, Hypoid Gears. Rack and Pinion-Worm and Worm Wheel gearing, velocity ratio of Worm gearing. Repairs to gear teeth by binding up and dovetail insert method. Method of fixing geared wheels for various purpose drives. General causes of the wear & tear of the toothed wheels & their remedies. Methods of fitting spiral gears, helical gears, bevel gears, worm and worm wheels in relation to required drives. Care and maintenance of gears.</p>	<p>Study of Various machine tools such as Lathe, Milling Grinding & shaping machine with special attention to transmission mechanism. Study of machine accessories, their function and operation. Study of lubrication systems and maintenance. Introduction to magnetic clamping devices such as magnetic chucks, lifting magnetworking principles, testing and safety aspects in handling/using such devices.</p>
<p>Method of reducing friction, Use of bearing advantages & disadvantages. Bearings-different types of high speed & low speed their application. Material for the bearings and their properties. Specification of bearings, dimensional relationship of the shaft with bearing-the type of loads. Method of clamping and fitting the bearing in the housing. Method of mounting and dismounting. Essentials of ordinary type Brass bearing-process of fitting. High speed and loaded bearings-use of ball and roller bearings- constructional features of ball & roller bearings and housings. Method of Ball and Roller bearings on the shafts. Commercial specifications of Ball and Roller bearings. Antifriction bearings-their types and uses. Lubrication of bearing high speed bearing . care and Maintenance and inspection of bearings.</p>	<p>--do-</p>

<p>--do--</p>	<p>Dismantling simple mechanisms such as machine vice, three jaw chucks, index head, tail stock, slotting attachment, coolant pumps, using various hand tools with specific referenc elements. Cleaning of Oiling of dismantled parts, Assembly & Testing for operation.</p>
<p>Introduction to maintenance work. Importance of maintenance. Methods & tools of maintenance, basic concepts of routine & preventive maintenance. Importance of preventive maintenance. Inspection, diagnosing and repairing procedure. Scheduling and planning for preventive maintenance work. Maintenance of records, log cards etc. Function involved in preventive maintenance. Advantages of preventive maintenance. Frequency of preventive maintenance-preparing preventive maintenance schedule-points to be considered, lubrication survey system of symbols and colour coding.</p>	<p>-do--</p>
<p>Methods of repairing damaged parts. Major overhauling. Reconditioning of machines methods of reconditioning measuring instruments used in re conditioning special tools, test mandrels, spooling gauges, bridges used in re-conditioning testing of machine after repair. Preparation of test chart.</p>	<p>Dismantling of simple machines such as Bench grinder, Pedestal Grinder, Sensitive Drilling machines. Cleaning & Oiling of parts & assembly & Testing.</p>
<p>Methods of various set ups. Reclamation of worn out parts such as slides, gears, shafts, broken parts of cast iron etc. by metal deposition hard chrome plating etc. Conservation of wear, forms of wear. Introduction of special tools used in maintenance voltmeter, Tachometer, Spirit Level etc. Materials used for leak proof joints. Preparation of gaskets and their mounting procedures. Sealing and Packing elements. Detection of common faults & their rectification in general. Painting. Procedure to prepare surface, use of protective coating, brush & spray painting on metallic & wooden articles, precaution to be observed during brush & spray painting.</p>	<p>Use of painting/protective coating for rust prevention. Surface operation, use of primers and surfaces. Brush and spray paintingpainting metallic and wooden articles. Lacquering practice.</p>
<p>Planning for scheduled overhauling of machine. Methods of dismantling, precautions to be taken while dismantling. Sequence of operations by making on parts. Methods of cleaning of parts. Solvents and cleaning materials their names and specifications. Proper method of removal and fitting of bearings. Re-assembly of machines in</p>	<p>Familiarization with electrical symbols being used in electrical circuit diagrams. Practice in reading electrical circuit/ connection diagrams from the instructional manual. Circuit tracing practice. Identifying electrical hardware items from their out look. Checking/testing of Relays, auxiliary</p>

<p>correct sequence and testing for correct functioning. Machine vice, three jaw chuck, index head, tail stock slotting attachments and coolant pumps using various hand tools with specific reference to functional parts for machines such as bench grinder, pedestal grinder, sensitive drilling machine etc. Advanced electrical electro-magnetism. Concept of a coil (Electromagnetic) and Capacitors-principles of operations. Use of a coil in hydraulic and Pneumatic solenoids. Use of a capacitors to store energy. electromagnetic induction,. Motor effect and generator effect. Electrical motors construction and features, types of both AC and DC motors and applications. Measurements of electrical quantities –Use of voltmeter, Ammeter and Multimeter-principles of operation. Elements of electrical system control power and safety elements. Circuit breakers, fuses, contractor, relays, timers-principles of operation & constructional details. Simple motor control, inching control, star delta control starter, push button switches, limit switches. Micro switch e s, pressure switches over load relays etc. Safety inter locks, Speed control of AC induction & DC motors. Automatic operation-use of control circuits-logical development of control circuit diagram using contractors and relays. Concept of ladder diagram. Understanding of power and control circuit in general (with few examples). Inter related between them. Safety in handling and operating electrical equipments.</p>	<p>contractors, power contractors by connecting appropriate power supply. Checking of contact operation (opening and closing) of relays and contractors. Developing control circuit using ladder/schematic diagrams. Use of control elements to build and test manual, inching, hold on and start/stop push button control circuits. Circuit building practice. Wiring of power and control circuit on test board such as direct on line starter, automatic star-delta starter and forward/reverse control for 3 dia. Induction motors etc. Study and use of safety elements such as miniature circuit breaker (MCB), over load relay, earth leakage repay, protecting fuses in power circuit wiring and testing. Measurement of winding and body resistance of DC motors and induction motors by Multimeter. Connecting induction motor to panel and measurement of line current. Simulated fault finding on control panel Isolation of machines from electrical cabinet by removing back up fuses, switching off main switch. Replacement of brushes, setting of brushes. Locating over loaded motor and finding out its causes such as fuse blown, mechanical jamming, loose connections, faulty settings etc. Locating faults in power circuit such as power fuse blown, MCB tripped, control fuse blown etc. Checking of electrical motors by measuring winding resistance, balance of resistance, body resistance. Checking of electromagnetic clutches, brakes, chuck magnet etc..</p>
<p>Visit to related Industrial Establishments or Revision & Test</p>	
<p>Introduction to logic gates e.g. AND, OR, INVERTER, NAND, NOR, EX-OR, etc. Their truth table analogy of logic gates, combination of series and parallel switches. Introduction to commonly used transducers in industries such as Timers of different types, counters, proximity switches (AC and DC), over current relays, DC motor controller, photo electric relays, temperature controller. Concept of programmable logic controllers-its fundamental blocks-input, output, memory, power supply, comparison of PLC with conventional terminal,</p>	<p>Introduction to logic gates and their truth tables. Building logic gates such as AND, OR, NOR, INVERTER, NAND, EX-OR using diodes and transistors out put lamps indicating conditions in truth table (Analogy of logic gates to series and parallel combination of switches). Study of commonly used Transducers-such as thermocouples, LDRS, thermistors, LVTs, strain gauges, magnetic pick up photo diodes, photo transistors etc. Familiarization with commonly used controls in our industry</p>

<p>function of various on PDT.</p>	<p>such as Timer, Counter, proximity switches (DC and AC), over current relays, DC motor controllers, photo electric relays, temperature controls. Demonstration of each controlling unit. Introduction to programmable logic controller (PLC-only concept). Its fundamental block such as input, output, memory, power supply etc. Comparison of PLC with conventional machine control (Appreciation only). Programme development terminal (PDT). Functions of keys on PDT.</p>
<p>Construction features, working principles and uses of pumps, positive and non positive displacement of pumps, gear pump, vane pump, piston pump, axial position and radial position pumps. Constructional features & working principles of valves, types of valves directional control, pressure control, flow control. Direction control valves according to their spool position e.g. 3/4 Dc, 2/3 DC types of spool. Check valves, types of check valves-application-construction and use, pilot operated check valve. Servo valves, block diagram of servo valve, mechanical servo, electrical servo, single stage spool servo, flapper type servo and jet type servo. Pressure control valve constructional features and working principles of simple relief valve-compound relief valve-("R" type relief valve-"R" type unloading valve-"R" type sequence valves-other types). Flow control valves constructional features and working principles of flow control valves and their uses. Meter in circuit, meter out circuit, bleeding off circuits. Compensating features, pressure, temperature and flow. Actuators constructional features and principles of hydraulic actuators. Hydraulic motor-Rotary actuators, hydraulic cylinders-types and their applications in hydraulic circuits, specifications cylinder cushioning.Study of stackable (modular) type hydraulic control valves. Study of manifolds ,accumulator, intensifier, rotary joints etc. Study of machine tools application of the hydraulic drives for rotary, reciprocating, speed changing, clamping, unclamping and feed motions. Pipes and pipe work-types and selection-specification, material, bending of pipes, pipe bending fixture and pipe bending methods. Standard fittings of</p>	<p>Circuit building practice-regenerative (sequencing) circuit with speed and pressure (clamping) control. Counter balance circuits with speed control. Traverse and feed circuits. Differential check valve, pressure regulator valve, pressure relief valve etc. Study of stackable (modular) type hydraulic control valves. Study of manifolds, accumulator, intensifier, rotary joints etc. Study of machine tool applications of the hydraulic drives for rotary, reciprocating, speed changing, clamping, unclamping and feed motions. Trouble shooting in hydraulic drive circuits for low pressure, noisy system, reduced speed of the table traverse, jerky traverse of machine table, jamming of piston rod at the end of the stroke, pressure increase in the system etc. Repairs and maintenance of the pumps-gear, vane and radial position. Repairs and maintenance of valves-pressure control, direction control and flow control. Adjustment of valves. Repairs and maintenance of actuators-single and double acting cylinders, hydraulic motors etc. Piping practice with metallic and hose pipes. Use of various types of pie joints and fittings. Precaution to be taken in storage and handling of oils. Study of pressure gauge, pressure selectors and filter units. Study of pressure, float, flow switches, suction strainer, return line & pressure line filters, Study of air oil cooler, water oil cooler, filler breather unit and tank accessories. Setting of various hydraulic elements for proper functioning. Repairs of hydraulic presses and various hydraulically operated equipment,</p>

<p>pipes e.g. ferrules, procedure for connecting pipe fitting work, installation of pipe, pipe storage . Flexible hoses-types and their specifications, uses according to the pressure in the line, correct insulation of flexible hoses and its importance. Constructional details, specification and uses of tank/reservoir, heat exchanger, heater, fitter/strainer, pressure gauge, intensifier, accumulators. Study of different types of hydraulic and lubricant oils. Introduction to seals and packing –types , their functions. Storage of seals. Fitters and their specifications. Methods of fault finding-rectification and remedies. Installation commissioning. Air venting and cavitations. Regular care of hydraulics.</p>	<p>fault finding by simulation.</p>
<p>Friction –its effect, methods of reducing friction. Use of lubricants, use of bearings. Lubrication-need and use. How it is done. Qualities of a good lubricant-viscosity of the lubricant-main properties of lubricant. How a film of oil is formed in journal bearing. Methods of lubrication-by gravity feed, forced feed, splash lubrication Lubrication grooves and ring lubrication. Effect of a thick and thin lubricant. Lubrication of high and low speed drives. Common lubricating oil's and greases, their specifications and commercial names. Selection of lubricant.</p>	<p>-do-</p>
<p>Constructional details, specifications, application of power unit, actuating unit, control unit. Power unit-types of compressors-reservoirs, condensers, filters, service units. Actuating units-single/double acting cylinders, rotary actuators, sander, disc grinder, nut runner etc. Control units-directional control, pressure control and flow control valves. Pipe and pipe fittings-materials, types, specifications and applications. Types of seals, packing and glands.</p>	<p>Circuit building practice-use of shuttle valves for control, circuit for speed regulation of single and double acting cylinder, circuits for indirect control on single³ and double acting cylinders, time dependent control circuits etc. Study of machine tool applications of pneumatics Use in low cost automation, manipulators, Material Handling equipment and pneumatic hand tools. Setting of pneumatic circuit elements for proper functioning –adjusting cushioning of the cylinders, flow, pressure etc. Repairing of pneumatic chisels, grinders, sanders, hammers, nut-spanners etc.</p>
<p>Background application, block diagram ,input devices, out put devices, CPU. Memory-RAM, ROM,PPROM,EPROM. Basic DOS commands, use of computer as CNC work station, communication between CNC & computer</p>	<p>History of computer(first generation to fifth generation), classification of computers, characteristics of computer block diagram, representation of characters in computers. Demonstration and explanation of different</p>

	<p>input, out put devices. Study of computer memories-RAM Access Memory, Read only Memory ,Erasable Programmable Read Only, Memory, Floppy ,hard disk etc.</p> <p>Study of central processing unit, structure of instructions, study of communication techniques between processor, input and output. Study of disk operating system, basic DOS commands (e.g.DIR,MD,CD,RD, COPY, FORMAT,DEL etc.) and practicing them. Introduction to different software packages such as WordStar, Lotus, DBase, Windows. Application of these software packages. Practicing simple commands such as create/open a file, close a file, saving of files etc. Explain use of computer as a CNC work station, communication between CNC & computer communication hardware, software.</p>
<p>Introduction to CNC machines. Difference between NC,CNC and GPM Importance of CNC machines over other mass production processes. Constructional details & working principles of CNC machines-machine beds-ball screw mechanism-servo drives-feed back mechanism etc. Axes designation. Introduction to G and M codes. CNC tooling and fixtures. Manual part programming.</p>	<p>Introduction to CNC technology.</p> <p>Study of special constructional and operational features with reference to driving mechanism, machine tool design, lubrication system. Familiarization with co-ordinate system, use of CNC codes and programming for simple test jobs.</p> <p>Manufacturing of simple jobs programmed on CNC trainer. Manufacturing of simple jobs programmed on CNC Trainer (contd.)</p> <p>Demonstrating the CNC machine features such as :-</p> <ul style="list-style-type: none"> i) Flexibility, efficiency, repeatability. ii) Axis movement-rapid, feed, jog, manual data input modes, over travel limits . iii) Axis driving elements-Servomotors, gear box, ball screw, position feed back, open loop, close loop control, following error, position loop. iv) Reference point, referencing procedure. v) Execution of part programme without tool(DRY RUN),plotting/tracing of job profile on paper by executing part programme for two axes interpolation for 5 to 6 different components.

<p>Spindle speed system:-</p> <ol style="list-style-type: none"> 1) True running of spindle assembly 2) To withstand for radial and axial load. 3) Types of spindle bearing-anti-friction, hydrodynamics, hydrostatics. 4) Pre-loading of spindle bearing. 5) Temperature rise test of spindle for proper preloading, lubrication of spindle. Lube. Oil cooler. 6) Study of gear box and automatic speed range for constant power & constant torque. 7) Maintenance of same as mentioned above. 8) Spindle orientation, de-clamping of tool from spindle head. 9) Coolant through spindle and rotary joints. 10) Coolant and chip disposal systems. 11) Study of tool holding, de-clamping devices, is-scraping, air purging, tool cleaning. 	<p>Study and practice of various CNC operating elements on CNC vertical machining center. CNC operation-referencing (zeroing), part programming execution of part programmes. Use of M/S/T/G codes, and tool offsets, zero offset. Cutter radius compensation facilities. Precautions to be followed while executing commands and part programmes.</p> <p>Practice on CNC machining center incorporating all available facilities</p>
<p>Linear axis feed system:-</p> <ol style="list-style-type: none"> 1) Study of re-circulating ball screw. 2) Basic elements of ball screw (external & internal) 3) Pre loading of ball screw, tension & compression of nut assemblies ,study of nut assembly. 4) Assembly of ball screw. 5) Maintenance of ball screw, proper lubrication, proper pre-loading to eliminate backlash, to reduce deflection & to optimize stiffness. 6) Guide ways, study of guide ways, LM & turcite guide ways friction, anti-friction, hydrostatics & centralized lubrication systems. 	<p>Introduction to CNC machine maintenance, use of maintenance card, history card & recording the data. Reading and analyzing of CNC alarm message during machine operation. Preventive maintenance of machine such as checking of lubrication oil level, coolant level, hydraulic oil levels</p>
<p>Study of :-</p> <ol style="list-style-type: none"> 1. Coolant and lubrication systems. 2. Rotary axis, automatic tool changer pallet changer assemblies. 3. Curvic coupling- to ensure indexing accuracy, to ensure mechanically high load bearing capacity. 4. Clamping and De-clamping –clamping by disc, springs and de-clamping by hydraulics or pneumatic. 5. Drive to rotary table-using servomotor or hydrometer. 6. Mounting of rotary encoder & linear optical scale on the axis. 	<p>Study of :-</p> <p>Spindle speed system :-</p> <ol style="list-style-type: none"> 1. True running of spindle assembly with radial & axial load. 2. Types of spindle bearing – antifriction, hydrodynamics, hydrostatics. 3. Pre-loading of spindle bearing . 4. Temperature rise test of lubrication of spindle. Lube oil, cooler. 5. Study of gear box and automatic speed range for constant power and constant torque. 6. Maintenance of same as mentioned above.

<p>7. Worm & Worm Wheel to eliminate backlash.</p> <p>8. Turret on CNC lathes, automatic tool changer, spindle orientation.</p> <p>9. Hydraulic clutch, tail stock , quill.</p> <p>10. Accuracy & performance of CNC m/cs. Problem and remedies.</p> <p>11. Inaccuracies such as backlash repeatability.</p> <p>12. Counter balancing mechanism.</p>	<p>7. Spindle orientation, de-clamping of tool from spindle head.</p> <p>8. Coolant through spindle and rotary joints.</p> <p>9. Coolants & chip disposal systems.</p> <p>10. Study of tool holding, de-clamping device, de-spring , air purging, tool cleaning</p>
<p>Hydraulic & Pneumatic power and circuits.</p> <p>Study of different hydraulic & pneumatic circuits Of CNC Turning, Milling, Grinding m/cs. Study of Hydraulic oil, air, coolant filtration system and hydraulic accessories.</p>	<p>Study of :-</p> <p>Linear axis feed system :-</p> <ol style="list-style-type: none"> 1. Re-circulating ball screw. 2. Basic elements of ball screw(External & internal). 3. Pre-loading of ball screw, tension & compression of nut assemblies, study of nut assembly. 4. Assembly of ball screw. 5. Maintenance of ball screw- proper lubrication, proper pre-loading to eliminate backlash, to reduce deflection & to optimize stiffness. 6. Guide ways, study of guide ways, friction, antifricition, hydrostatic & centralized lubrication systems
<p>Study of :-</p> <ol style="list-style-type: none"> 1. Electrical /electronic circuits for a CNC m/c. 2. CNC system hardware. 3. Feed and spindle drives. 4. Feed back devices. 5. Programmable logic controller 6. Safety interlocks. 	<p>Study of “-</p> <ol style="list-style-type: none"> 1. Coolant and lubrication systems. 2. Rotary axis, automatic tool changer pallet changer assemblies. 3. Curvic coupling- to ensure indexing accuracy, to ensure mechanically high load bearing capacity . 4. Clamping and De-clamping – clamping by disc, springs and de-clamping by hydraulic or pneumatic. 5. Drive to rotary table- using servomotor or hydro motor. 6. Mounting of rotary encoder & linear optical scale on the axis. 7. Worm & Worm Wheel to eliminate backlash. 8. Turret on CNC lathes, automatic tool change, spindle orientation . 9. Hydraulic chuck tail stock, quill. 10. Accuracy & performed of CNC m/cs. Problem and remedies.

	<p>11. Inaccuracies such as backlash, repeatability.</p> <p>12. Counter balancing mechanism</p>
-do-	<p>Hydraulic & Pneumatic power source and circuits. Study of different hydraulic & pneumatic circuits of CNC Turning, Milling, Grinding m/cs. Study of hydraulic oil, air, coolant filtration system and hydraulic accessories.</p>
-do-	<p>Study of :-</p> <ol style="list-style-type: none"> 1. Electrical /electronic for a CNC m/c 2. CNC system hardware. 3. Feed and spindle drives. 4. Feed back devices. 5. Programmable logic controller. 6. Machine power supply. <p>Safety interlocks.</p>
Revision & Test	

List of Tools and Instrument for Maintenance Shop

Sr. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Steel rule 300 mm graduated both side in Metric and English	IS:1481-1970	10 Nos.
2	Inside spring caliper 150 mm	IS:4052-1967	10 Nos.
3	Outside spring caliper 150 mm	IS:4052-1967	10 Nos.
4	Spring divider 150 mm	IS:4083-1967	10 Nos.
5	Hermophrodite caliper 150 mm		10 Nos.
6	Try square 150 mm	IS:2103-1962	10 Nos.
7	Hack saw frame adjustable 300 mm	IS:5169-1969	10 Nos.
8	Hammer Ball Peen with handle 200 gms.	IS:841-1963	10 Nos.
9	Hammer Ball Peen with handle 400 gms.	IS:841-1963	10 Nos.
10	Cold chisel 20 x 200 mm	IS:402-1964	10 Nos.
11	Cross cut chisel 10 x 150 mm		10 Nos.
12	Half round chisel 10 x 150 mm		10 Nos.
13	Diamond point chisel 10 x 150 mm		10 Nos.
14	Centre punch 100 mm	IS:7177-1974	10 Nos.
15	Prick punch 100 mm		10 Nos.
16	File flat bastard 300 mm	IS:1931-1972	10 Nos.
17	File flat 2ndcut 250 mm		10 Nos.
18	File flat bastard 300 mm		10 Nos.
19	File lat smooth 200 mm		10 Nos.
20	Round Nose Plier 200 mm		10 Nos.
21	Combination plier 200 mm	IS:3650-1973	10 Nos.
22	File half round 2ndcut 250 mm	IS:1931-1972	10 Nos.
23	File three square smooth 200 mm		10 Nos.
24	File round smooth 200 mm		10 Nos.
25	File square smooth 200 mm		10 Nos.
26	File needle set of 12 nos.	IS:3152-1965	10 Nos.
27	Scraper A 250 mm (Bearing)		10 Nos.
28	Scraper B 250 mm (Triangular)		10 Nos.
29	Scraper D 250 mm (half round)		10 Nos.
30	Spindle blade screw driver 100 mm	IS:844-1962	10 Nos.
31	Allen Hexagonal keys 2 to 16 mm		10 Nos.
32	Card file		10 Nos.
33	Scriber 150 x 3 mm (one side offset)		10 Nos.

List of Tools and Instrument for Maintenance Sheet

Sr. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Master bar 45 degree scraping bar 600 mm width of bar 75 mm, thickness 25 mm, all sides an accuracy of 0.02 mm seasoned.		1 No.
2	Master flat scraping test bar 600 mm, length 75 x75 mm sq. in cross section all sizes scraped to an accuracy of 0.02 mm per 300 mm seasoned.		1 No.
3	Tap and die M6 to M 12 with tap necessary tap wrench and die holder.		1 set
4	Spanner socket set of 25 pieces (10 to 25, 27, 30, 32 mm = 18 pieces and accessories = 7 Nos.		1 set
5	Hammer soft (faced 30 mm dia. Plastic tipped)		2 Nos.
6	Pipe wrench 45 mm		1 No.
7	Chain pipe wrench 65 m		1 No.
8	Self alignment roller ball bearing	IS:4025-1967	1 No.
9	Telescopic gauges 13 mm to 300 mm		1 set
10	Lubricant trolley 2400 x 1200 x 1200 mm (8 chamber)		1 No.
11	Cellepsable tool kit 5 compartments		1 No.
12	Tap extractor		1 No.
13	Gear pump		1 No.
14	Vane pump fixed and variable delivery		1 each
15	Piston pump (radial and axial)		1 each
16	Linear actuator (differential and non-differential)		1 each
17	Hydrameter		1 No.
18	Accumulator (spring and gas)		1 no.
19	Pneumatic tools (portable nut spanner/runner, chisel, grinder, sander and hammer.		1 each
20	Hydraulic, pneumatic trainer with necessary aggregates for different machine circuit with all type of transparent valves and pressure gauge, reservoir etc.		1 each trainer
21	Hydraulic valves (relief, sequence, unloading, pressure reducing, check, flow control, directional control valves etc.).		1 each
22	Transparent hydraulic cylinder		1 No.
23	Transparent gear pump		1 No.
24	Transparent vane pump		1 No.
25	Cut model of pneumatic valve		1 No.
26	Vibrometer		1 No.
27	Flow detector(magnetic crack detector)		1 No.
28	Machine tool calibrator		1 No.
29	Lathe tool dynamometer		1 No.

30	Engg. Stethoscope		1 No.
31	Stud extractor		1 No.
32	Tool picker collet type		1 No.
33	Tool picker magnet type		1 No.
34	Magnifying glass 75 mm	IS:5148-1965	2 Nos.
35	Pin spanner set		1 set
36	Hand key way broacher		1 No.
37	Granite surface plate 1600 x 1000 with stand and cover.		1 No.
38	CI surface plate 400 x 400 mm with wooden stand and cover	IS:2285-1063	1 No.
39	Solenoid valve		1 No.
40	Pneumatic meter		1 No.
41	Head lamp		1 No.
42	Bearing and gear tester		1 No.
43	Pneumatic scraper with adjustable stroke		1 No.
44	Hydraulic wheel and bearing puller		1 No.
45	Master test bars (different size)		1 set
46	Level bottle (sprit) 150 ml.		1 No.
47	Three cell torch		1 No.
48	Gasket hollow punches 5, 6, 8, 10, 12, 19, 25 mm dia		1 each
49	Bar type torque wrench		1 No.
50	Cam lock type screw driver		1 No.
51	Flaring tool		1 No.
52	Tube expander up to 62 mm		1 set
53	Circlip pliers (inside and outside and straight)		1 set
54	SRDG ball bearing, DRDG ball bearing, self aligning ball bearing, SRAC ball bearing, needle bearing, single row cylindrical roller bearing, tapered roller bearing, plain bush bearing, thin walled bearing.		1 each
55	Sledge hammer 5 kgs.		1 No.
56	Viscometer		1 No.

Precision Instrument

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Vernier height gauge 500 mm	IS:2921-1964	1 No.
2	Vernier bevel protractor with 150 mm blade	IS:4239-1970	1 No.
3	Vernier caliper A 200 with inside and depth measurement	IS:3651-1974	1 No.
4	Direct reading vernier caliper B 300 (direct reading with dial)	IS:3651-1974	1 No.
5	Optical bevel protractor		1 No.
6	Outside micrometer 0 to 25 mm	IS:2967-1964	1 No.
7	Outside micrometer 25 to 50 mm		1 No.
8	Outside micrometer 50 to 75 mm		1 No.
9	Outside micrometer 75 to 100 mm		1 No.
10	Combination set with 300 m scale , center head, sq. head and protractor head		1 No.
11	Sine bar 200 mm	IS:5359-1969	1 No.
12	Slip gauge metric set (for the whole institute)	IS:2984-1966	1 set (box)
13	Internal micrometer 5 to 30 mm	IS:2966-1964	1 No.
14	Vernier tooth caliper (metric)		1 No.
15	Bevel gauge 200 mm		1 No.
16	Dial gauge type 1 Gr. A (complete with clamping devices and stand)	IS:2092-1962	1 No.
17	Feeler gauge	IS:3179-1976	1 No.
18	Radius gauge (metric)	IS:5273-1969	1 No.
19	Screw pitch gauge for metric pitches (0.25 to 6 mm)	IS:4211-1967	1 No.
20	Center gauge 55 degree to 47 ½ degree		1 No.
21	Centre gauge 60 degree		1 No.
22	Plug gauge, plain	IS:2251-1965 & 3484-1966	1 No.
23	Ring gauge Morse taper No. 1, 2, 3, 4	IS:1715-1963	1 set
24	Ring gauge 5 to 25 by 2.5 mm (Go and No Go)	IS:2251-1965	1 set
25	Limit plug gauges 5 to 25 mm by 2.5 mm	IS:2251-1965	1 set
26	Wire gauge	IS:1137-1950	1 No.
27	Bore dial gauge (0.01 mm dial)		1 No.
28	Indicator with magnetic base		1 No.
29	Straight edge 485 mm to 1445 mm	IS:2220-1962	1 set
30	Adjustable micrometer spirit level to measure flatness, indication and taper with prismatic measuring base	IS:2220-1962	1 No.

Machinist Tools

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Cylindrical milling cutter B 63 x 90	IS:1831-1961	1 No.
2	Side and face milling cutter B 160 x 10	IS:6308-1971	1 No.

3	Side and face milling cutter B 160 x 10 (inserted type)		1 No.
4	Slot milling cutter B 10 x 6	IS:6352-1971	1 No.
5	Equal angle cutter 450/100	IS:6326-1971	1 No.
6	Equal angle cutter 600/100	IS:6326-1971	1 No.
7	Single angle cutter B 63 x 18 x 450(L.H.) and (R.H.)	IS:6324-1971	1 each
8	Single angle cutter B 63 x 18 x 600(L.H.) and (R.H.)	IS:6324-1971	1 each
9	Slot drill (Key seating) 3,4,5,6,8,12 mm parallel shank	IS:5031-1969	1 set
10	Slitting saw B 80 x 3		1 No.
11	Slitting saw B 100 x 4		1 No.
12	T-slot cutter to suit T headed bolt of 10, 12 mm S.S.	IS:2668-1964	1 each
13	Convex milling cutter 4,10, 20 mm	IS:6322-1971	1 each
14	Concave milling cutter 4,10, 20 mm	IS:6322-1971	1 each
15	Corner rounding milling cutter 2.5, 4, 10, 16 mm	IS:6314-1971	1 each
16	Woodruff key seating cutters A 13.5 x 3, A 16 x 4, A 9.5 x 5, A 19.5 x 6		1 each
17	End mill cutter SS 3, 6, 10, 12, 18, 22 mm		1 each
18	Milling gear cutter (involute) 1, 2, 2.5, 3 module set of 8 cutter		1 set
19	Fly cutter holder		1 No.
20	Engineers parallel	IS:4241-1967	1 set
21	Scribing block universal 300 mm		4 Nos.
22	V-block 100/7-80-A	IS:2949-1964	1 pair
23	Straight edge (steel) 1000 mm	IS:2022-1962	1 No.
24	Sprit level 2 V 250.05	IS:5706	1 No.
25	Spanner D.E.G.P. series 2	IS:2028-1968	1 set
26	Table chuck 3 jaw with tightening arrangement and graduated in degrees		1 No.
27	Machine vice 200 mm swivel base		1 No.
28	Machine vice swivel base 160 mm		1 No.
29	Angle plate size 4 with slots	IS:2554-1963	1 No.
30	Angle plate adjustable 250 x 150 x 175 mm		1 No.
31	Twist drill 3 to 13 mm (SS)	IS:5701-1969	1 set
32	Twist drill 13 to 25 mm by 1 mm (T.S)		1 set
33	Grinding wheel dresser (diamond) 1.5 carret		1 set
34	C-Clamp 150 mm and 200 mm		1 set
35	Hand reamer 6 to 25 mm by 1 mm	IS:1836-1961	1 set
36	Punch letter set 4 mm		1 set
37	Punch number set 4 mm		1 set
38	Mandrel 120 mm long different sizes		1 No.
39	Wheel balancing stand with its accessories		1 set
40	Pin punch 3 to 10 mm by 1 mm		1 set
41	Deep cutting hack saw frame 300 mm		2 Nos.
42	Machine reamer 6 to 25 mm by 1 mm		1 set

Masonry

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Wooden straight edge 300, 600, 900, 1200 mm		1 each
2	Man on chisel		1 No.
3	Pick axes		1 No.
4	Bar bending tools and cutting tools		1 No.
5	Four fold foot rule		1 No.
6	Plumb Bob		1 No.
7	Masons tool for plaster work		1 No.

Lathe Tools

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Drill chuck 30 mm		1 No.
2	Reduction sleeve and extension sockets		1 each
3	Centre drill 1 to 5 mm	IS:664-1963	1 set
4	Revolving centers with Arbor		1 No.
5	Knurling tool with holder (straight, cross and diamond)	IS:6335-1971	1 set
6	Lathe carriers up to 75 mm		1 set
7	Oil stone 150 x 50 x 25 mm		1 No.
8	Oil cane pressure feed 500 mm		1 No.
9	Boring tool holder (Armstrong) LH 8 and 10 sq. bit size x length 200 mm		1 No.
10	Tool holder 8 and 10 sq. bit size straight x length 200 mm		1 No.

General Machine

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Lathe general purpose all geared height of center 150 mm to below, Gao bed between centers 1000 mm with all accessories with all attachment.		1 No.
2	Lathe general purpose all geared height of center 150 mm to below, between centers 1000 mm with 3 jaw and 4 jaw chuck, coolant equipments only.		1 No.
3	Milling machine, universal motorized No. 1 with all attachments.		1 No.
4	Surface grinding machine wheel dia. 180 mm (or near) reciprocating table, longitudinal table traverse 200 mm (or near) full motorized supplied with magnet chuck 250 x 120 mm and necessary accessories.		1 No.
5	Cylindrical universal grinding machine		1 No.
6	Drilling machine pillar 20 mm capacity		1 No.
7	Bench grinder 250 mm dia. (lighter type)		1 No.
8	Flexible hand grinder 100 mm dia. (lighter type)		1 No.
9	Portable drilling machine 6 mm capacity		1 No.
10	Tensile and Brinell hardness testing machine		1 No.
11	CNC Trainer		1 No.
12	Shaping machine 450 mm stroke (motorized) with all attachments		1 No.
13	Pipe bending machine (hydraulic)		1 No.

Machine For Repair And Reconditioning

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Old center lathe		1 No.
2	Old milling machine (universal)		1 No.
3	Old grinding machine (universal)		1 No.
4	Old shaping machine		1 No.
5	Old press (power)		1 No.
6	Old turret and capstan		1 No.
7	Universal indexing head		1 No.
8	Revolving center		1 No.
9	Tail stock		2 Nos.
10	Gear box (old)		2 Nos.

Sr. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Oxy-acetylene welding cylinder trolley		1 No.
2	Welding hose of P.V.C. flexible internal dia. 6 mm (blue, red)		5 Nos.
3	Hose coupling nipples		1 No.
4	Hose protractor		1 No.
5	Double stage pressure regulator (oxygen) and double stage pressure regulator (acety.)		1 each
6	Blow pipe with tips high pressure		1 No.
7	Gas cutting torch with cutting tips		1 No.
8	Welding gloves pair (leather)		1 pair
9	Goggles (4A) for gas welding		3 Nos.
10	Spark lighter		3 Nos.
11	Spindle key		1 No.
12	Gas welding table with fire bricks		1 No.

(Arc Welding)

Sr. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	DC welding generator 150-300 amps. Complete to AC induction with all accessories		1 No.

For Heat Treatment

Sr. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Blacksmith's Anvil, 200 kg.		1 No.
2	Smiths tongs hollow bit, Smiths tongs flat (30 mm)		1 each
3	Water tank (450 x 300 x 250 x 6 mm)		1 No.
4	Brass rule 300 mm		1 No.
5	Furnace for heat treatment		1 No.
6	Oil bath (for quenching) 45 x 45 x 45 6 mm thick plate		1 No.

Sheet Metal Work

Sr. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Forge power operated 45 mm dia 150 mm blower		1 No.
2	Soldering copper bit 450 gm		1 each
3	Metal cutting shears 300		1 No.
4	Mallet (plastic or rose wood) ord. And rectangular 75 x 75 x 50 mm		1 No.
5	Conical mallet		1 No.
6	Half moon stake		1 No.
7	Beak iron		1 No.
8	Funnel stake		1 No.
9	Hatchet stake		1 No.
10	Snap rivet set A-3, A-4		1 No.

Hoisting Equipment

Sr. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Forks clips 02 tonnes (copa)		1 No.
2	Forks clips 05 tonnes (copa)		1 No.
3	Manila ropes 12, 20, 30 mm dia.		1 each
4	Crow bar		2 Nos.
5	Rollers (steel tubes) from 40 to 65 mm dia.		5 Nos.
6	Block of timber (various sizes)		5 Nos.
7	Portable jack		1 No.
8	Carge winches 3, 5 tonnes		1 No.
9	Wall hoists		1 No.
10	Traveling and gantry cranes		1 No.
11	Shear legs (tripod)		1 No.
12	Hand operated chain pulley block		1 No.
13	Mobile crank		1 No.
14	Conveyor		1 No.
15	Elevators		1 No.
16	Ratchet chain pulley		1 No.

Erection Tools And Equipment

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Foundation bolt		4 Nos.
2	Plumb bob		1 No.
3	Square box wrenches		1 No.
4	Square T-wrenches		1 No.
5	Engineers square 700 mm		1 No.
6	Threaded fastener type B		1 No.
7	Threaded fastener type C		1 No.
8	Threaded fastener type F		1 No.

Furniture

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Metal lockers 8-lockers type with individual locks 1980 x 910 x 480 mm		1 No.
2	Metal office chair with arm, cane sit and back		1 No.
3	Metal office table with three drawers		1 No.
4	Work bench		2 Nos.
5	Metal shelving rack open type 1800 x 900 x 500 mm with adjustable shelves		2 Nos
6	Drawing desk		1 No.
7	Stool		1 No.
8	Black board with easel milky glass with graph line		1 No.
9	Portable fire extinguisher		1 No.
10	Galvanized milled steel fire bucket 4 liters		2 Nos.

Sl. No.	Name of the Tools & Equipment	IS: Code Number	Quantity
1	Screw driver electrician 150 mm		10 Nos.
2	Screw driver Philips Nos. 860, 862, 862		10 Nos.
3	Long nose plier 150 mm insulated		10 Nos.
4	Combination plier 150 mm		10 Nos.
5	Diagonal cutter 150 mm		10 Nos.
6	Tweezers		10 Nos.
7	Knife 100 mm		10 Nos.
8	Neon tester		10 Nos.
9	Scissors 150 mm		10 Nos.
10	Soldering iron 25 W		10 Nos.
11	Soldering iron 65 W		10 Nos.
12	Multimeter		2 Nos.
13	Ammeter 0 mA to 500 mA		1 No.
14	Ammeter 0-1 A DC		1 No.
15	Voltmeter 0-300-600 V AC		1 No.
16	Discrete component trainer		1 No.
17	P.F.Meter		1 No.
18	Frequency meter		1 No.
19	Megger 500 V		1 No.
20	AC squirrel cage induction motor 30 with D.O.L. starter		1 No.
21	Star delta 30 starter		1 No.
22	C.T. single phase		1 No.
23	P.T. single phase		1 No.
24	Auto transport 0-300 V, 8 Amp.		1 No.
25	C.R.O. 50 MHZ		1 No.
26	Digital I.C. tester		1 No.

27	Digital I.C. trainer		1 No.
28	Audio signal generator		1 No.
29	DC power supply 0-30 V, 2 Amp.		1 No.
30	Demonstration model for thyristorised DC motor drive (1 HP) set up		1 No.
31	Demonstration model for thyristorised AC motor drive (1 HP) set up		1 No.
32	Linear I.C. trainer		1 No.
33	Digital multi-meter 2.5 Amps./5 Amps		1 No.
34	Transducer		1 No.
35	Thermocouple kit		1 No.
36	L.D.R.S. kit		1 No.
37	Thermister kit		1 No.
38	L.V.D.T. kit		1 No.
39	Strain gauge		1 No.
40	Photo diode		1 No.
41	Photo transistor kit		1 No.
42	AC timer kit		1 No.
43	DC timer kit		1 No.
44	Decimal counter kit		1 No.
45	DC motor control kit		1 No.
46	Hand tachometer		1 No.
47	Ammeter portable type 0-15 Amps. AC		1 No.
48	Insulated handle screw driver 200 mm		2 Nos.
49	Insulated handle combination side cutting plier 200 mm		2 Nos.
