SYLLABUS FOR MACHINIST TRADE			
FIRST YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 150Hrs.; Professional Knowledge 42Hrs.	Plan and organize the work to make job as per specification applying different types of basic fitting operation and check for dimensional accuracy following safety precautions. [Basic fitting operation – marking, Hack sawing, Chiselling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.25mm]	1. Importance of trade training, List of tools & Machinery used in the trade.(02hr.) 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (07hrs.) 3. First Aid Method and basic training.(04hrs.) 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (03hrs.) 5. Hazard identification and avoidance. (04hrs.) 6. Identification of safety signs for Danger, Warning, caution & personal safety message.(03 hrs.) 7. Preventive measures for electrical accidents & steps to be taken in such accidents.(04hrs.) 8. Use of fire extinguishers.(07hrs.) 9. Practice and understand precautions to be followed while working in fitting jobs. (03hrs.) 10. Safe use of tools and equipments used in the trade.	All necessary guidance to be provided to the newcomers to become familiar with the working of Industrial Training Institute system including store's procedures. Soft skills, its importance and job area after completion of training. Importance of safety and general precautions observed in the industry/shop floor. Introduction of first aid. Operation of electrical mains and electrical safety. Introduction of PPEs. Response to emergencies e.g. power failure, fire, and system failure. Importance of housekeeping & good shop floor practices. Introduction to 5S concept & its application. Occupational Safety & Health: Health, Safety and Environment guidelines, legislations & regulations as applicable. Basic understanding on Hot work, confined space work and material handling equipment. (07 hrs.)

		(03 hr)	
		11. Study the drawing to plan the job/ work. Identification of tools &equipments as per desired specifications for marking, filing& sawing. (04hrs.) 12. Visual inspection of raw material for rusting, scaling, corrosion etc. (02 hrs.) 13. Familiarisation of bench vice. (02 hr) 14. Filing- Flat and square (Rough finish). (08 hrs.) 15. Marking with scriber and steel rule.(03hrs.) 16. Filing practice, surface filing, marking of straight and parallel lines with odd leg calipers and steel rule. (06hrs.)	Linear measurements- its units, steel rule dividers, callipers – types and uses, Punch – types and uses. Uses of different types of hammers. Description, use and care of marking off table. (07 hrs.)
		17. Marking out lines, gripping suitably in vice jaws, hack sawing to given dimensions. (09hrs.) 18. Sawing different types of metals of different sections. (09hrs.) 19. Marking practice with dividers, odd leg callipers, scriber and steel rule (circles, arc,parallel lines). (07hrs.)	Bench vice construction, types, uses, care & maintenance, vice clamps, hacksaw frames and blades, specification, description, types and their uses, method of using hacksaws. Files- elements, types, specification and their uses. Methods of filing. Care and maintenance of files. Measuring standards (English, Metric Units) (07 hrs.)
		20. Grinding, centre punch, dot punch, chisel and scriber.(07hrs.) 21. Marking off straight lines and arcusing scribing block and dividers. (08hrs.)	Pedestal grinding machine: Use, care and safety aspect. Marking off and layout tools, scribing block, care & maintenance. Try square, ordinary depth gauge,

		22. Marking, filing, filing square and check using try-square. (15 hrs.)	Care & maintenance of cold chisels- materials, types, cutting angles. Combination set- its components, uses and cares. (07 hrs)
		23. Marking according to drawing for locating, position of holes, scribing lines on chalked surfaces with marking tools. (07hrs.) 24. Finding centre of round bar with the help of 'V' block and marking block. (06hrs.) 25. Prepare mushroom head and round bar and bending metal plate by hammering. (10hrs.) 26. Marking using scale, surface gauge and angle plate. (07 hrs.)	Marking media, Prussian blue, red lead, chalk and their special application, description. Surface plate and auxiliary marking equipment, 'V' block, angle plates, parallel block, description, types, uses, accuracy, care and maintenance. (07 hrs.)
Professional Skill 50 Hrs; Professional Knowledge 14 Hrs.	Produce components by different operations and check accuracy using appropriate measuring instruments. [Different Operations - Drilling, Reaming, Tapping, Dieing; Appropriate Measuring Instrument – Vernier, Screw Gauge, Micrometre]	27. *Chipping flat surfaces along a marked line. (07hrs.)* 28. *Make a square from a round job by chipping upto 20mm length. (06hrs.)* 29. *Slot, straight and angular chipping. (05hrs.)* 30. Mark off and drill through holes. (05hrs.) 31. Drill and tap on M.S. flat. (04hrs.) 32. Cutting external thread on M.S. rod using Die.(03hrs.) 33. Punch letter and number (letter punch and number punch). (03hrs.) 34. Counter sinking, counter boring and reaming with accuracy +/- 0.04 mm.(05 hrs.) 35. Drill blind holes with an	Drill, Tap,Die-types & application. Determination of tap drill size. Basic terminology related to screw thread. Reamer- material, types (Hand and machine reamer), parts and their uses, determining hole size for reaming, Reaming procedure. Vernier height gauge: construction, graduations, vernier setting & reading. Care and maintenance of Vernier height Gauge. (07 hrs.) Drilling machines-types &their application, construction of Pillar & Radial drilling machine. Countersunk, counter bore and spot facing-tools and

		accuracy 0.04 mm.(02 hrs.) 36. Form internal threads with taps to standard size (blind holes).(03 hrs.) 37. Prepare studs and bolt.(07hrs.)	nomenclature. Cutting Speed, feed, depth of cut and Drilling time calculations. (07 hrs.)
Professional Skill 100 Hrs.; Professional Knowledge 28 Hrs.	Make different fit of components for assembling as per required tolerance observing principle of interchangeability and check for functionality. [Different Fit – Sliding, 'T' fitand Square fit; Required tolerance: ±0.2 mm, angular tolerance: 1 degree.]	38. Make Male & Female 'T' fitting with an accuracy +/- 0.2 mm and 1 degree. (25hrs.) 39. Make male female square fit with accuracy +/- 0.1 mm. (25hrs.) 40. Make Male & Female Hexagon fitting with accuracy +/- 0.06 mm. (50 hrs.)	Interchangeability: Necessity in Engg., field, Limit- Definition, types, terminology of limits and fits-basic size, actual size, deviation, high and low limit, zero-line, tolerance zone, allowances. Different standard systems of fits and limits. (British standard system & BIS system) (14 hrs) Vernier calliper-its parts, principle, reading, uses & care. Outside micrometre- its parts, principle, reading, uses,Reading of VernierMicrometre), care & maintenance. Dial test indicator-its parts, types, construction and uses. (14 hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 07 Hrs.	Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. [Different chucks: 3 jaws & 4 jaws, different shaped jobs: round, square, hexagonal]	41. Identify & function of different parts of lathe. Practice on operation of lathe (dry/idle run). (10 hrs.) 42. Setting lathe on different speed and feed.(05 hrs.) 43. Dismantling, assembling & truing of 3-jaw & 4-jaw chucks. (10hrs.)	Getting to know the lathe with its main components, lever positions and various lubrication points as well. Definition of machine & machine tool and its classification. History and gradual development of lathe. Introduction to lathe- its types. Centre lathe construction, detail function of parts, specification. Safety points to be observed while working on a lathe. (07 hrs.)

Professional Skill 125 Hrs.; Professional Knowledge 35 Hrs.	Prepare different cutting tool to produce jobs to appropriate accuracy by performing different turning operations. *[Different cutting tool – V tool, side cutting, parting, thread cutting (both LH& RH), Appropriate accuracy: ±0.06mm, Different turning operation – Plain, facing, drilling, boring (counter & stepped), grooving, Parallel Turning, Step Turning, parting, chamfering, U -cut, Reaming, knurling.]*	44. Grinding of R.H. and L.H. tools, V- tool, parting tool, Round nose tool. (15 hrs.) 45. Checking of angles with angle gauge/ bevel protractor. (02 hrs.) 46. Grinding of "V" tools for threading of Metric 60-degree threads. (08 hrs.)	Lathe cutting tool-different types, material, shapes and different angles (clearance, rake etc.) and their effects, specification of lathe tools, grinding process of tools. Types of chips, chip breaker. Tool life, factors affecting tool life. (07 hrs.)
		47. Perform facing operation to correct length. (05 hrs.) 48. Centre drilling and drilling operation to required size. (05 hrs.) 49. Perform parallel turning and step turning operation. (15 hrs.)	Driving mechanism, speed and feed mechanism of Lathe. (07 hrs)
		50. Perform drilling, boring and undercut operation, parting, grooving, chamfering practice. (48 hrs.) 51. Measurement with steel rule and outside calliper with an accuracy of ± 0.5 mm. (02 hrs.)	Concept of Orthogonal and Oblique Cutting. Chucks & different types of job holding devices on lathe and advantages of each type. Mounting and dismounting of chucks. Vernier Bevel Protractor – parts, reading and uses. (14 hrs)
		52. Perform different Knurling operation in lathe with accuracy of ± 0.5 mm (10 hrs.) 53. Perform Drilling & boring of blind hole with an accuracy of ± 0.3 mm (15 hrs.)	Lathe operations-facing, turning, parting-off,grooving, chamfering, boring etc. Knurling-types, grade & its necessity. (07 hrs)
Professional Skill 50 Hrs.; Professional	Set different components of machine & parameters to produce taper/	54. Make taper turning by form tool with an accuracy of 1 degree. (05 hrs.) 55. Make taper turning by	Taper – different methods of expressing tapers, different standard tapers. Method of taper turning, important dimensions of

Knowledge 14 Hrs.	angular components and ensure proper assembly of the components. *[Different component of machine: Form tool, Compound slide, tail stock offset; Different machine parameters- Feed, speed, depth of cut.]*	compound slide swivelling with an accuracy of ± 30 minute (20 hrs.)	taper. Taper turning by swiveling compound slide, its calculation. (07 hrs.)
		56. Make taper by off-setting tailstock with an accuracy of ± 30 minute. (20 hrs.) 57. Checking taper by Vernier Bevel Protractor and sine bar & slip gauge. (05 hrs.)	Calculations of taper turning by off-setting tail stock. Sine Bar – description & uses. Slip gauge –description and uses. (07 hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 14 Hrs.	Set the different machining parameters to produce metric-v threaded components applying method/ technique and test for proper assembly of the components.	58. Cutting V thread (external) in a lathe and check with Screw Pitch Gauge. (22 hrs.) 59. Cutting V thread (internal) in a lathe and check with Screw Pith Gauge. (25 hrs.) 60. Fitting of male & female threaded components. (03 hrs.)	Different thread forms, their related dimensions and calculations of screw cutting in a lathe (Metric thread on English lathe and English thread on Metric lathe). Measurement of threads by three wire methods. Use of Screw Pitch Gauge. (14 hrs.)
Professional Skill 100 Hrs.; Professional Knowledge 28 Hrs.	Set the different machining parameters and cutting tool to prepare job by performing different slotting operation. *[Different machining parameters – feed, speed and depth of cut. Different slotting operations –concave & convex surface, internal key ways, profiling, making internal sprocket with an accuracy of +/- 0.04 mm]*	61. Identification of slotting machine parts & its construction, use of rotary table. (10 hrs.) 62. Practice on slotting key ways on pulley with accuracy +/- 0.04 mm (15 hrs.)	Slotter– Classification, principle, construction, Safety precaution. Introduction and their indexing process on a Slotter by its Rotary table graduations. Driving mechanisms, quick return motion and speed ratio. Safety points to be observed while working on a Slotter. (07 hrs.)
		63. Slotting a double ended spanner with accuracy +/- 0.1 mm. (25 hrs.)	Job holding devices-vice, clamps, V-block, parallel block etc. Slotting tools- types, tool angles. (07 hrs)
		64. Cutting sprocket teeth on slotting machine with accuracy +/- 0.04 mm. (25 hrs.)	Use of tool with holder for internal operations. Precautions to be observed during slotting

			internal operations. Use of circular marks on the table for slotting curves. Chain, Sprocket and their applications. (07 hrs)
		65. Cutting internal spline on slotting machine with accuracy +/-0.04 mm. (25 hrs.)	Spline – types and uses. **Coolant & lubricant –** Introduction, types, properties, application & applying methods. (07 hrs)
Professional Skill 150 Hrs.; Professional Knowledge 42 Hrs.	Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing. [Different machining parameters – feed, speed and depth of cut. Different milling operations – plain, face, angular, form, gang, straddle milling]	66. Identification of milling machine. (02 hrs.) 67. Demonstrate working principle of Milling Machine. (04 hrs.) 68. Set vice & job on the table of Milling Machine. (05 hrs.) 69. Set arbor on the spindle of milling machine. (08 hrs.) 70. Set the cutter on arbour. (04 hrs.) 71. Safety points to be observed while working on a milling machine. (02 hrs.)	Milling Machine: Introduction, types, parts, construction and specification. Driving and feed mechanism of Milling Machine. (06 hrs)
		72. Demonstrate Up Milling and Down Milling Process. (05hrs.) 73. Sequence of milling six faces of a solid block. (08 hrs.) 74. Check the accuracy with the help of try-square and vernier height gauge. (02hrs.) 75. Perform Step milling using side and face cutter checking with depth micrometer. (05hrs.) 76. Perform slot milling using side and face cutter. (05hrs.)	Different types of milling cutters & their use. Cutter nomenclature. (06 hrs)
		77. Make “V” Block using Horizontal	Different milling operations -

		Milling Machine with accuracy +/-0.02 mm. (20hrs.)	plain, face, angular, form, slot, gang and straddle milling etc. Up and down milling. (06 hrs)
		78. Make concave surfaces with an accuracy +/-0.02 mm. (04 hrs.) 79. Make convex surfaces with an accuracy +/-0.02 mm. (04 hrs.) 80. Straddle milling operation with an accuracy +/-0.02 mm. (07 hrs.) 81. Gang milling operation with an accuracy +/-0.02 mm. (08hrs.)	Different types of milling attachments and their uses. (06 hrs)
		82. Make Dovetail fitting (male & female) on Milling Machine with an accuracy +/-0.02 mm. (18hrs.)	**Jigs and Fixtures–** Introduction, principle, types, use, advantages & disadvantages. (06 hrs)
		83. Make T-Slot fitting (male & female) on Milling Machine with an accuracy +/-0.02 mm. (18hrs.)	Properties of metals general idea of physical, mechanical properties of metals, colour, weight, hardness toughness, malleability, ductility their effect on machinability. Heat Treatment – Introduction, necessity, types, Purposes, different methods of Heat Treatment. Heat Treatment of Plain Carbon Steel. (06 hrs)
		84. Demonstrate indexing head. (04hrs.) 85. Set and align indexing head with reference to job on milling machine.(04hrs.) 86. Make square job by direct/ simple indexing method with an accuracy +/-0.02 mm. (05hrs.) 87. Make hexagonal job by simple indexing method with an	Indexing-introduction & types. Indexing head-types &constructional details, function of indexing plates and the sector arms. Calculation for various types of indexing. (06 hrs)

		accuracy +/-0.02 mm. (08hrs.)	
Professional Skill 75 Hrs.; Professional Knowledge 21 Hrs.	Set the different machining parameters to produce square & "V'' threaded components applying method/ technique and test for proper assembly of the components.	88. Checking of alignment of lathe centres and their adjustments. (03 hrs.) 89. Turning practice-between centres on mandrel (gear blank) with an accuracy +/-30 minute. (07 hrs.) 90. Taper turning by swivelling the cross slide.	Turning of taper by taper turning attachment - advantages and dis-advantages, taper calculations. Mandrel, Lathe centres, Lathe dog, catch plate/Driving plate, Face plate, Rests, their types & uses. (07 hrs)
		91. Make square thread (external) on a lathe with an accuracy +/- 0.02 mm. (12hrs.) 92. Make square thread (internal) on a lathe with an accuracy +/- 0.02 mm. (15hrs.) 93. Check with thread gauge – grinding of tool & setting in correct position. (04hrs.) 94. Fitting of male & Female Square threaded components. (02hrs.) 95. Make multi-start V thread on lathe with Screw Pitch gauge.(10 hrs.) 96. Perform eccentric turning with an accuracy +/-0.02mm. (07hrs..)	Terms relating screw thread major/ minor diameter, pitch and lead of the screw, depth of thread. Simple gear train and compound gear train change gears for fractional pitches. Square thread and its form and calculation of depth, core dia, pitch dia. Difference between single and multi-start threads- their uses, merits and demerits. (14 hrs.)
Professional Skill 125 Hrs.; Professional Knowledge 35 Hrs.	Produce components of high accuracy by different operations using grinding. [*Different operations – surface grinding, cylindrical grinding with an accuracy of+/- 0.01 mm*]	97. Identification of different types of grinding machine. (02 hrs.) 98. Wheel balancing & truing. (06 hrs.) 99. Dressing of grinding wheel. (02 hrs.) 100. Grinding of block (six sides) by surface grinding machine with an accuracy of +/- 0.01 mm. (15 hrs.)	**Grinding –** Introduction, grinding wheel-abrasive, types, bond, grade, grid, structure, standard marking system of grinding wheel, selection of the grinding wheel. (06 hrs.)

		101. Grinding of step block by surface grinding machine with an accuracy of +/- 0.01 mm. (10hrs.) 102. Grinding of slot block by surface grinding machine with an accuracy of +/- 0.01 mm. (08hrs.)	Dressing, types of dresser. Glazing and Loading of wheels – its causes and remedies. Roughness values and their symbols. Explain the importance and necessity of quality. (06 hrs.)
		103. Set and perform angular grinding using universal vice/ sign vice to standard angle. (05 hrs.) 104. Make slide fit with an accuracy ± 0.01mm (male female) (05hrs.) 105. Perform form grinding (05 hrs.) 106. Make dovetail fitting with an accuracy ± 0.01mm (male & female) (08 hrs.)	**Surface Grinder –** Types, Parts, construction, use, methods of surface grinding, specification & safety. (06 hrs.)
		Cylindrical grinding: 107. External parallel cylindrical grinding (Both holding in chuck/ collet and in between centers. (10 hrs.) 108. Plunge grinding (08 hrs.)	**Cylindrical grinder:** Introduction, parts, construction, types, specification, safety, different methods of cylindrical grinding. (06 hrs.)
		109. Perform straight bore grinding (05hrs.) 110. Perform step bore grinding (05hrs.) 111. Internal taper bore grinding (05hrs.) 112. Make male female fitting with an accuracy of +/- 0.01 mm (08hrs.)	Cutting speed, feed, depth of cut, machining time calculation. (06 hrs.)
		113. External step cylindrical grinding with an accuracy of +/- 0.01 mm (10hrs.)	Wet grinding and dry grinding, various types of grinding wheels and their application, grinding

		114. External taper Cylindrical grinding with an accuracy of +/- 0.01 mm. (08hrs.)	defects and remedies. (05 hrs.)

In-plant training/ Project work

Broad area:

a) Drill extension socket
b) V-belt pulley
c) Tail Stock Centre (MT – 3)
d) Taper ring gauge
e) Taper plug gauge. (Morse taper – 3)

SYLLABUS FOR MACHINIST TRADE			
SECOND YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 75 Hrs.; Professional Knowledge 27 Hrs.	Re-sharpen different single & multipoint cutting tool. [Different single point tools, slab milling cutter, side & face milling cutter, end mill cutter and shell end mill cutter.]	115. Demonstrate and practice of grinding of different single point tools. (25 hrs.)	**Tool & cutter grinder-** Introduction, parts, construction, use and specification, different types of tool rest & their application. (09 hrs.)
		116. Demonstrate and practice of grinding of slab milling cutter. (13 hrs.) 117. Re-sharpening side and face milling cutter. (12 hrs.)	Various methods of cutter grinding. (09 hrs.)
		118. Demonstrate and practice of grinding of end mill cutter. (10 hrs.) 119. Re-sharpening of shell end mill cutter. (15 hrs.)	Various cutter grinding attachments and their uses. (09 hrs.)
Professional Skill 75 Hrs; Professional Knowledge 27 Hrs.	Set different machining parameters and cutters to prepare job by different milling machine operations. *[Different machining parameters - feed, speed, depth of cut, different machining operation – facing, drilling, tapping, reaming, counter boring, counter sinking, spot facing, and boring slot*	120. Practice of facing on milling Machine. (10 hrs.) 121. Drill on P.C.D on milling Machine with accuracy +/- 0.02 mm. (15 hrs.)	Geometrical tolerances, definition, symbol and their application. Depth Micrometer – Parts, reading, uses and safety. (09 hrs.)
		122. Perform Tapping and Reaming operation using milling Machine with an accuracy +/- 0.02 mm.(10hrs.) 123. Perform spot facing operation using milling machine with accuracy +/-0.02 mm. (15 hrs.)	Different types of micrometers and their uses. Inside Micrometer – its parts, reading and uses. Bore Dial Gauge – its parts, reading (both in Metric and English system) and uses. Telescopic gauge. (09 hrs.)
		124. Make slot on face of the job using milling Machine with an accuracy +/-0.02 mm. (10 hrs.)	Gauges – different types and their uses, difference between Gauges and Measuring Instruments.

	cutting.]	125. Make Internal Grooving using milling Machine with an accuracy 0.02 mm. (15 hrs.)	Gear introduction, use and type. Elements of a spur gear. Gear tooth of each forms types, merits and demerits of each. (09 hrs.)
Professional Skill 100Hrs.; Professional Knowledge 36Hrs.	Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. *[Different machining parameters – feed, speed and depth of cut. Different components – Rack, Spur Gear, External Spline, Steel Rule, Clutch, Helical Gear]*	126. Make Straight Teeth Rack using Milling Machine with an accuracy 0.05 mm. (08 hrs.) 127. Make Helical Teeth Rack using Milling Machine with an accuracy 0.05 mm one straight rack. (08 hrs.) 128. Measurement of teeth by Vernier Gear Tooth Caliper. (05 hrs.)	Rack – types, uses and calculations. Selection of gear cutter type and form & various methods of checking gear and its parts. Vernier gear tooth caliper - its construction and application in checking gear tooth. (08hrs.)
		129. Make spur gear using Simple indexing with an accuracy 0.05 mm. (08 hrs.) 130. Make spur gear using differential indexing with an accuracy 0.05 mm. (12 hrs.)	Spur gear calculations, curves and their uses. Use of radius gauges and template. (07hrs.)
		131. Perform Boring operation on Vertical Milling Machine with an accuracy 0.05 mm. (18 hrs.)	Vertical Milling Machine- its parts. Method of boring in Vertical milling. Difference between Horizontal and Vertical Milling Machine. (07hrs.)
		132. Make helical gear on milling machine with an accuracy 0.05 mm. (20 hrs.)	Helix and Spiral introduction, types and elements. Difference between helix & spiral. Difference between R.H. and L.H. helix. Helical gear- elements, application. Calculations for cutting helical gear. (07hrs.)
		133. Make straight flute milling on Milling Machine with an accuracy 0.05 mm. (10 hrs.) 134. Make helical flute on Milling Machine with an accuracy 0.02 mm. (11 hrs.)	Reamer – types, elements and uses. Calculations for cutting Reamer. Twist drill-nomenclature, cutter selection. Calculations for cutting twist drill. (07hrs.)

Professional Skill 50 Hrs; Professional Knowledge 18Hrs.	Identify and explain basic functioning of different electrical equipment, sensors and apply such knowledge in industrial application including basic maintenance work. [*Different electrical equipment- multi-meter, transformer, relays, solenoids, motor & generator; different sensors – proximity & ultrasonic.*]	135. Measure Current, Voltage and Resistance using Simple Ohm`s Law Circuit And Familiarizing Multi-meter. (05hrs.) 136. Soldering Techniques (05hrs.) 137. Step up and step-down transformers. (05hrs.) 138. Working with Solenoids and Relays. (05hrs.) 139. Working of Motor & Generators. (05hrs.) 140. Behaviour of Proximity Sensors. (05hrs.) 141. Behaviour of ultrasonic sensors. (05hrs.) 142. Logical Operation of Sensors. (05hrs.) 143. Limit & Level Control using Sensors. (05hrs.) 144. Interfacing of Sensors with Electrical Actuators. (05hrs.)	Study of basic Electricals- Voltage – Current etc. Working Of Solenoids, Inductors, Motors, Generator Based On Electromagnetic Induction Principle Switches, Fuse and Circuit Breakers Introduction To Sensors-Fundamental Of Sensor Proximity Sensors Classification and Operation-Proximity Sensor-Types Of Proximity Sensor And Their Working-Industrial Application Sensors For Distance And Displacement -LVDT-Linear Potentiometer-Ultrasonic And Optical Sensors-Industrial Application. (18hrs.)
Professional Skill 200 Hrs.; Professional Knowledge 72 Hrs.	Set (both job and tool) CNC turning centre and produce components as per drawing by preparing part programme.	145. Know rules of personal and CNC machine safety, safe handling of tools, safety switches and material handling equipment using CNC didactic/ simulation software and equipment. (03 hrs.) 146. Identify CNC lathe machine elements and their functions, on the machine. (07 hrs.) 147. Understand the working of parts of CNC lathe, explained using CNC didactic/ simulation software. (09 hrs.) 148. Identify machine over travel	Personal safety, safe material handling, and safe machine operation on CNC turning centers. CNC technology basics, Comparison between CNC and conventional lathes. Concepts of positioning accuracy, repeatability. CNC lathe machine elements and their functions - bed, chuck, tailstock, turret, ball screws, guide ways, LM guides, coolant system, hydraulic system, chip conveyor, steady rest, console, spindle motor and drive, axes motors, tail stock, encoders, control switches. Feedback, CNC interpolation, open

		limits and emergency stop, on the machine. (01 hr) 149. Decide tool path for turning, facing, grooving, threading, drilling. (04hrs.) 150. Identification of safety switches and interlocking of DIH modes. (01 hr)	and close loop control systems. Machining operations and the tool paths in them – stock removal in turning and facing, grooving, face grooving, threading, drilling. (09hrs.)
		151. Identify common tool holder and insert shapes by ISO nomenclature. (05hrs.) 152. Select cutting tool and insert for each operation. (03hrs.) 153. Fix inserts and tools in tool holders. (02hrs.) 154. Decide cutting tool material for various applications. (03hrs.) 155. Select cutting parameters from tool manufacturer's catalogue. (02hrs.) 156. Write CNC programs for simple tool motions and parts using linear and circular interpolation, check on program verification/ simulation software. (10hrs.) 157. Write CNC part programs using canned cycles for stock removal, grooving, threading operations, with drilling and finish turning. Use TNRC commands for finish turning. Check simulation on program verification/ simulation software. (20hrs.) 158. Avoiding collisions caused by program errors. Knowing	Concept of Co-ordinate geometry, concept of machine coordinate axis, axes convention on CNC lathes, work zero, machine zero. Converting part diameters and lengths into co-ordinate system points. Absolute and incremental programming. Programming – sequence, formats, different codes and words. ISO G codes and M codes for CNC turning. Describe CNC interpolation, open and close loop control systems. Co-ordinate systems and Points. Program execution in different modes like MDI, single block and auto. Canned cycles for stock removal (turning/facing), grooving, threading, for external and internal operations. Tool nose radius compensation (TNRC) and why it is necessary. Find the geometry page in CNC machine. Cutting tool materials, application of various materials. Cutting tool geometry for internal and external turning, grooving,

		causes and effects of collisions due to program errors, by making deliberate program errors and simulation on program verification/ simulation software. (05 hrs.)	threading, face grooving, drilling. Insert holding methods for each. Insert cutting edge geometry. ISO nomenclature for turning tool holders, boring tool holders, Indexable inserts. Cutting parameters- cutting speed, feed rate, depth of cut, constant surface speed, limiting spindle speed. Tool wear, tool life, relative effect of each cutting parameter on tool life. Selection of cutting parameters from a tool manufacturer's catalogue for various operations. Writing part programs as per drawing & checking using CNC program verification/ simulation software. Process planning, work holding, tool and cutting parameters selection according to the part geometry and dimensions. Collisions due to program errors, effects of collisions. Costs associated with collisions – tool breakage, machine damage, injuries. (18hrs.)
		159. Conduct a preliminary check of the readiness of the CNC lathe - cleanliness of machine, functioning of lubrication, coolant level, correct working of sub-systems, on the machine. (05 hrs.) 160. Starting the machine, do homing on CNC simulator. (02 hrs.)	Program execution in different modes like MDI, single block and auto. Process planning & sequencing, tool layout& selection and cutting parameters selection. Work and tool offsets. Inputs value to the offset/ geometry page into machine. Turning in multiple setups, hard

		161. Entering the CNC program in EDIT mode for an exercise on Simple turning & Facing (step turning) without using canned cycles, on CNC simulator. (15 hrs.) 162. Mounting jaws to suit the part holding area on CNC machine (03hrs.) 163. Mounting tools on the turret according to part and process requirement, on CNC simulator &on CNC machine. (08hrs.) 164. Perform Work and tool setting: Job zero/work coordinate system and tool setup and live tool setup. (08hrs.) 165. Determining work and tool offsets using JOG, MDI, MPG modes, on CNC simulator. (08hrs.) 166. Entering the tool offsets, tool nose radii and orientation for TNRC in offsets page, on CNC simulator. (05hrs.)	and soft jaws, soft jaw boring, use of tailstock and steady rest. Length to diameter (L/D) ratio and deciding work holding based on it. Machine operation modes – Jog, MDI, MPG, Edit, Memory. Entering and editing programs on machine console, entering offsets data in offsets page. Use of Emergency stop, Reset, Feed rate override, spindle speed override, edits lock on/off buttons and keys. (18hrs.)
		167. Program checking in dry run, single block modes, on CNC simulator & CNC machine. (01hr) 168. Absolute and incremental programming assignments and simulation. (04 hrs.) 169. Checking finish size by over sizing through tool offsets, on CNC simulator. (02hrs.) 170. Prepare part program and cut	First part checking: Program checking in single block and dry run modes – necessity and method. Tool offsets adjustment on first part for close tolerance dimensions, by over sizing (for outside dimensions) or under sizing (for inside dimensions) the dimension to prevent part rejection.

		the part in auto mode in CNC machine for the exercise on Simple turning & Facing (step turning) (08 hrs.) 171. Recovering from axes over travel, on CNC simulator (01 hr) 172. Part program writing, setup, checking and Automatic Mode Execution for exercise on Turning with Radius/ chamfer with TNRC on CNC machine (10hrs.) 173. Part program writing, setup, checking and Automatic Mode Execution for exercise on Turning with TNRC, grooving and threading, on CNC simulator & on CNC machine (12hrs.) 174. Checking finish size by over sizing through tool offsets, on the machine. (02 hrs.) 175. Machining parts on CNC lathe with combination step, taper, radius turning, grooving &threading, with external and internal operations, first and second operation, on the machine. (10 hrs.) 176. Machining long part on CNC lathe held in chuck and tailstock (between centers). (04 hrs.) 177. Starting from interruption due to power shutdown, tool breakage. (01hr) 178. Changing wear offsets to take	Wear offset setting – necessity, relationship with tool wear, entering in offsets page. Process and tool selection related to grooving, drilling, boring and threading. Axes over travel, recovering from over travel. Collisions due to improper machine setup and operation – causes and effects. Recovering from collisions. Find out alarm codes and meaning of those codes. (27hrs.)

		into account tool wear. (02hrs.) 179. Part program preparation, Simulation & Automatic Mode Execution of CNC Machine for the exercise on Blue print programming contours with TNRC. (08 hrs.) 180. Carryout Drilling/Boring cycles in CNC Turning. (10 hrs.) *(First 60% of the practice is on CNC machine simulator, followed by 40% on machine.)*	
Professional Skill 350 Hrs.; Professional Knowledge 126Hrs.	Set CNC VMC (vertical machining center) and produce components as per drawing by preparing part program.	181. Know rules of personal and CNC machine safety, safe handling of tools and material handling equipment. Using CNC didactic/ simulation software and equipment. (02 hrs.) 182. Identify CNC vertical machining center machine elements and their functions, on the machine. (20 hrs.) 183. Understand working of parts of CNC VMC, explained using CNC didactic/ simulation software (20 hrs.) 184. Identify machine over travel limits and emergency stop, on the machine. (05hrs.) 185. Decide tool path for Face milling, Side milling, Pocket milling, Drilling, Counter sinking, tapping, Reaming, Rough boring, Finishboring,Spot facing. (03hrs.)	Safety aspects related to CNC VMC.CNC technology basics, Comparison between CNC VMC and conventional milling machines. Concepts of positioning accuracy, repeatability. CNC VMC machine elements and their functions - bed, chuck, Auto tool changer (ATC), ball screws, guide ways, LM guides, coolant system, hydraulic system, chip conveyor, rotary table, pallet changer, console, spindle motor and drive, axes motors, encoders, control switches. Feedback, CNC interpolation, open and close loop control systems. Machining operations and the tool paths in them - Face milling, Side milling, Pocket milling, Drilling, Countersinking, Rigid tapping, floating tapping Reaming, Rough boring, Finish boring, Spot facing. (18 hrs)

		186. Identify common tools, tool holders and inserts. (05 hrs.) 187. Select cutting tool, insert and holder for each operation. (05 hrs.) 188. Fix inserts and tools in tool holders. (03 hrs) 189. Decide cutting tool material for various applications. (04 hrs.) 190. Select cutting parameters from tool manufacturer's catalog. (02 hrs) 191. Write CNC programs for simple parts using linear and circular interpolation, absolute and incremental modes, checkon program verification software. (15 hrs.) 192. Write CNC part programs for parts with face milling, pocket milling with subprograms. Check on program verification software. (11hrs.) 193. Write CNC part programs for pocket milling, drilling with canned cycle, countersinking with canned cycle, tapping with canned cycle. Check on program verification software. (14hrs.) 194. Avoiding collisions caused by program errors. Knowing causes and effects of collisions due to program errors, by making deliberate program errors and	Concept of Co-ordinate geometry& polar coordinate points, concept of machine axis, axes convention on CNC lathes, work zero, machine zero. Converting part dimensions into coordinate system points. Absolute and incremental programming. Programming - sequence, formats, different codes and words. ISO G and M codes for CNC milling. Canned cycles for drilling, peck drilling, reaming, tapping, finish boring. Subprograms. Cutter radius compensation (CRC)and why it is necessary. Cutting tool materials, application of various materials. Cutting tool geometry for face mill, end mill, drill, countersink, tap, finish bore, reamer. Insert holding methods face mill, insert type end mill and insert type drill. Insert cutting edge geometry. Cutting parameters- cutting speed, feed rate, depth of cut. Tool wear, tool life, relative effect of each cutting parameter on tool life. Selection of cutting parameters from a tool manufacturer's catalog for various operations. Writing part programs as per drawing & check using CNC program verification software. Process planning, work holding,

		simulation on program verification software. (06 hrs.)	tool and cutting parameters selection according to the part geometry and dimensions. Collisions due to program errors, effects of collisions. Costs associated with collisions - tool breakage, machine damage, injuries. (27hrs.)
		195. Conduct a preliminary check of the readiness of the CNC VMC - cleanliness of machine, functioning of lubrication, coolant level, correct working of sub-systems. On the machine. (03 hrs.) 196. Starting the machine, do homing on CNC simulator. (03 hrs.) 197. Entering the CNC program in EDIT mode for an exercise on face milling and drilling without using canned cycles, on CNC simulator. (20 hrs.) 198. Mounting tools on the ATC according to part and process requirement, on CNC simulator & CNC machine. (08hrs.) 199. Determining work and tool offsets using JOG, MDI, MPG modes, on CNC simulator& CNC machine. (07hrs.) 200. Tool change in CNC milling and JOG, MDI, MPG mode operation. (06 hrs.) 201. Entering the work offset, tool length offsets, tool radii and, on CNC simulator. (03hrs.)	Program execution in different modes like manual, single block and auto. Process planning & sequencing, tool layout & selection and cutting parameters selection. Work offset, tool length offset, tool radius offset. Work holding with temporary holding and fixtures. Truing of part and fixture. Machine operation modes - Jog, MDI, MPG, Edit, Memory. Entering and editing programs on machine console, entering offsets data in offsets page. Use of Emergency stop, Reset, Feed rate override, spindle speed override, edit lock on/off buttons and keys. (18hrs.)

		202. Program checking in dry run, single block modes, on CNC simulator. (04 hrs.) 203. Checking finish size by over or under sizing through tool offsets, on CNC simulator. (05 hrs.) 204. Prepare part programme, enter, edit and simulate. (04 hrs.) 205. Carryout tool path simulation. (04 hrs.) 206. Recovering from axes over travel, on virtual machine simulator (03 hrs.) 207. Part program writing, setup, checking and Automatic Mode Execution for exercise on side milling with CRC, on CNC simulator & CNC machine. (15 hrs.) 208. Part program writing, setup, checking and Automatic Mode Execution for exercise on face milling, drilling, countersinking, tapping using canned cycle, on CNC simulator & CNC machine (20 hrs.) 209. Automatic mode execution of CNC Machine Exercises with Block Search and restart. (12 hrs.) 210. Mounting clamps, locators, supports, truing part and fixture. (8 hrs.)	First part checking: Program checking in single block and dry run modes -necessity and method. Tool offsets adjustment on first part for close tolerance dimensions, by oversizing (for outside dimensions) or under sizing (for inside dimensions) the dimension to prevent part rejection. Axes over travel, recovering from over travel. Collisions due to improper machine setup and operation - causes and effects. Recovering from collisions. State the importance of Helical inter-polar and thread milling, advantage and limitation in CNC machine. (27hrs.)
		211. Machining part on CNC VMC with face milling, drilling. (05	Tool wear and necessity for wear offsets change, entering wear

		hrs.) 212. Machining parts on CNC VMC with combination face milling, side milling with CRC, drilling, countersinking, tapping. Use canned cycles and subprograms wherever possible. (05 hrs.) 213. Machining of part with closely controlled slot dimension usingCRC. (05hrs.) 214. Machining of part with pockets. (02 hrs.) 215. End milling with polar co-ordinates. (04 hrs.) 216. Part programs & Simulation Automatic Mode Execution of CNC Machine for the exercise on End milling with polar co-ordinates and practical on Simple drilling-G 81. (06 hrs.) 217. Determining and entering wear offsets. (03 hrs.) 218. Restarting machine from power shutdown or sudden stoppage. (01hr) 219. Program transfer to machine through electronic media – USB and flash drive. (01 hr) 220. Merging the work zero with program zero point, geometry and wear offset correction. (02 hrs.) 221. Practical on Chamfer and counter-sink drilling. (02 hrs.) 222. Carryout Deep hole drilling G 83. (03 hrs.) 223. Perform Threading and tapping	offsets in offsets page. Effects of sudden machine stoppage due to power shutdown or use of emergency stop. Restarting machine from sudden stoppage. Means of program transfer through electronic media. Productivity concepts, cycle time, machine down time, causes of down time - breaks, machine breakdown, inspection, part loading and unloading, chip cleaning. Effect of down time on profitability, reducing down time. Machine hour rate, components of machine hour rate - principal repayment, interest, overheads (power, tooling, space, salaries, indirect expenses). Calculation of machining cost, cost of down time. (27hrs.)

		G 84. (06 hrs.) 224. Carryout Boring cycles G 85 - G 89. (08 hrs.) 225. Preparations of part programs for thread cutting/thread milling for CNC machining centres.(06 hrs.) 226. Drilling milling patterns, Thread milling etc. (03 hrs.) 227. Circular and rectangular pockets machining. (03 hrs.) 228. Calculation of machine hour rates for typical CNC lathe and VMC.(05 hrs.) 229. Estimation of cycle time for parts with face milling, side milling, drilling, tapping operations. (05hrs.) *(First 60% of the practice is on CNC machine simulator, followed by 40% on machine.)*	
		230. Prepare different types of documentation as per industrial need by different methods of recording information. (25 hrs.)	Machine productivity concepts – cycle time, down time, cycle time estimation. Costing - machine hour rate, machining cost, tool cost, cost of down time. Importance of Technical English terms used in industry. Technical forms, process sheet, activity log, job card, in industry-standard formats.(09hrs.)
Professional Skill 50 Hrs.; Professional Knowledge 18 Hrs.	Plan and perform simple repair, overhauling of different machines and check for functionality.	231. Perform Periodic Lubrication system on Machines. (10 hrs.) 232. Perform simple repair work.(15hrs.)	Lubricating system-types and importance. (09hrs.)
		233. Perform the routine maintenance with check list.	Maintenance: Definition, types and its necessity.

	[Different Machines - Drilling Machine, milling machine and Lathe]	(05hrs.) 234. Inspection of Machine tools such as alignment, leveling etc. (10 hrs.) 235. Accuracy testing of machine tools such as geometrical parameters.(10 hrs.)	System of symbol and colour coding. Possible causes for failure and remedies. (09hrs.)
Professional Skill 100Hrs; Professional Knowledge 36Hrs.	Set the different machining parameters and cutters to prepare components by performing different milling operation and indexing. *[Different machining parameters - feed, speed and depth of cut. Different components - end mill, bevel gear, cam, worm & worm wheel]*	236. Cutting teeth on helical slab/ cylindrical cutter and end mill cutter with an accuracy of +/- 0.05 mm. (20 hrs.)	Calculations for cutting helical slab/ cylindrical cutter. Calculations for cutting End Mill cutter. (07hrs.)
		237. Cutting bevel gears on a milling machine with an accuracy of +/-0.05 mm. (20 hrs.)	Bevel gear-elements, types, application, calculation for cutting bevel gear. (07 hrs.)
		238. Cutting a plate cam with angular setting in milling machine with an accuracy of +/-0.05 mm. (20 hrs.)	Cam-types, elements & application, Plate cam-manufacturing & calculations. Drum cam- its calculation, advantages, types of follower & its purposes. (07hrs.)
		239. Cutting worm wheel on a milling machine with an accuracy of +/- 0.05 mm. (20 hrs.)	Worm wheel-application, elements & calculation, Worm-calculation.(07hrs.)
		240. Cutting worm thread on a milling machine with an accuracy of +/- 0.05 mm. (20 hrs.)	Types of Keys and their uses. Variation - types and causes. Testing of Gear and error. (08hrs.)

In-plant training/ Project work (Any Project to be done involving CNC machine also)

Broad area:

a) Socket with Split Collet
b) Screw Jack
c) Crank Shaft with Taper Sleeve
d) Crank and slotted link mechanism
e) Stub arbor with collet and nuts
f) Compound gear train