Syllabus for the Post of Junior Technician (Machining)-Level A1

Essential Qualification: High School or Class X Equivalent Board Examination with Science and Trade Certificate in Machining.

Part (A): General Mental Ability and Aptitude	20% (20 questions carrying 1 mark each)

General Mental Ability and Aptitude to test the following:

- Interpersonal Skills
- Logical reasoning/Analytical/Comprehension ability
- Basic Numeracy and Data Interpretation Skills
- General Awareness

Part (B): Subject/Domain Related	80 % (80 questions carrying 1 mark each)

1. Importance of trade training, List of tools & Machinery used in the trade; Importance of safety and general precautions observed in the industry/shop floor; Introduction of first aid , First Aid Method and basic training; Safe disposal of waste materials like cotton waste, metal chips/burrs etc.; 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.
2. 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.
3. 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)
4. Pedestal grinding machine: Use, care and safety aspect. Marking off and layout tools, scribing block, care & maintenance. Try square, ordinary depth gauge, Care & maintenance of cold chisels- materials, types, cutting angles. Combination set- its components, uses and cares.
5. 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.
6. 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.

7. Drilling machines - types &their application, construction of Pillar & Radial drilling machine. Countersunk, counter bore and spot facing-tools andnomenclature. Cutting Speed, feed, depth of cut and Drilling time calculations.
8. 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)
9. Vernier calliper-its parts, principle, reading, uses & care. Outside micrometre- its parts, principle, reading, uses, Reading of Vernier Micrometre), care & maintenance. Dial test indicator-its parts, types, construction and uses.
10. 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.
11. 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. Driving mechanism, speed and feed mechanism of Lathe.
12. 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.
13. Lathe operations-facing, turning, parting-off, grooving, chamfering, boring etc. Knurling-types, grade & its necessity.
14. Taper – different methods of expressing tapers, different standard tapers. Method of taper turning, important dimensions oftaper. Taper turning by swivelling compound slide, its calculation. Calculations of taper turning by off-setting tail stock. Sine Bar – description & uses. Slip gauge –description and uses.
15. 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.
16. 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.
17. Job holding devices-vice, clamps, V-block, parallel block etc. Slotting tools- types, tool angles. 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.
18. Spline – types and uses. Coolant & lubricant – Introduction, types, properties, application & applying methods.
19. Milling Machine: Introduction, types, parts, construction and specification. Driving and feed mechanism of Milling Machine. Different types of milling cutters & their use. Cutter nomenclature. Different milling operations - plain, face, angular, form, slot, gang

and straddle milling etc. Up and down milling. Different types of milling attachments and their uses.

20. Jigs and Fixtures– Introduction, principle, types, use, advantages & disadvantages.
21. Properties of metals general idea of physical, mechanical properties of metals, colour, weight, hardness toughness, malleability, ductility their effect on machinability.
22. Heat Treatment – Introduction, necessity, types, Purposes, different methods of Heat Treatment. Heat Treatment of Plain Carbon Steel.
23. Indexing- introduction & types. Indexing head-types &constructional details, function of indexing plates and the sector arms. Calculation for various types of indexing.
24. Turning of taper by taper turning attachment - advantages and disadvantages, taper calculations. Mandrel, Lathe centres, Lathe dog, catch plate/Driving plate, Face plate, Rests, their types & uses.
25. 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.
26. Grinding – Introduction, grinding wheel- abrasive, types, bond, grade, grid, structure, standard marking system of grinding wheel, selection of the grinding wheel. 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.
27. Surface Grinder – Types, Parts, construction, use, methods of surface grinding, specification & safety. Cylindrical grinder: Introduction, parts, construction, types, specification, safety, different methods of cylindrical grinding. Cutting speed, feed, depth of cut, machining time calculation. Wet grinding and dry grinding, various types of grinding wheels and their application, grinding defects and remedies.
28. Tool & cutter grinder- Introduction, parts, construction, use and specification, different types of tool rest & their application. Various methods of cutter grinding. Various cutter grinding attachments and their uses.
29. Geometrical tolerances, definition, symbol and their application. Depth Micrometer – Parts, reading, uses and safety. 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.
30. Gauges – different types and their uses, difference between Gauges and Measuring Instruments.Gear introduction, use and type. Elements of a spur gear. Gear tooth of each forms types, merits and demerits of each.
31. 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. Spur gear calculations, curves and their uses. Use of radius gauges and template.
32. Vertical Milling Machine- its parts. Method of boring in Vertical milling. Difference between Horizontal and Vertical Milling Machine.
33. 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.

34. Reamer – types, elements and uses. Calculations for cutting Reamer. Twist drill- nomenclature, cutter selection. Calculations for cutting twist drill.
35. 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.
36. 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, openand close loop control systems. Machining operations and the tool paths in them – stock removal in turning and facing, grooving, face grooving, threading, drilling.
37. 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, 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.
38. 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, hardand 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.

39. 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. 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.
40. 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.
41. 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, 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.
42. 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, edits lock on/off buttons and keys.
43. 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.

44. Tool wear and necessity for wear offsets change, entering wearoffsets 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.
45. 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.
46. Lubricating system-types and importance.
47. Maintenance: Definition, types and its necessity.System of symbol and colour coding. Possible causes for failure and remedies.
48. Calculations for cutting helical slab/ cylindrical cutter. Calculations for cutting End Mill cutter. Bevel gear-elements, types, application, calculation for cutting bevel gear.
49. Cam-types, elements & application, Plate cam manufacturing& calculations. Drum cam-its calculation, advantages, types of follower & its purposes.
50. Worm wheel-application, elements & calculation, Worm calculation.
51. Types of Keys and their uses. Variation - types and causes. Testing of Gear and error.
52. **Workshop Science and Calculation** :
    - Introduction to Iron and Steel. Differences in Iron & steel.
    - Introduction to Property and uses of C.I. and wrought Iron. , Iron and steel properties and uses.
    - Properties and uses of plain carbon steel and alloy steel.
    - Properties and uses of non ferrous metals and alloys Fraction and decimal - conversion fraction decimal and vice-versa.
    - Properties and uses of copper, zinc, lead, tin, aluminum.
    - Composition, properties and uses of brass, bronze, solder, bearing material, timber, rubber etc.
    - System of units, British, metric and SI units for length, area, volume capacity, weight, time, angle, their conversions. , Effect of alloying elements in the properties of C.I. & steel.
    - Unit of temperature for & related problems. Standard & absolute temp.
    - Mass, volume, density, weight, sp. Gravity & specific weight. S.I. M.K.S. and F.P.S. units of force, weight etc. their conversion to related problems.
    - Inertia, rest and motion, velocity and acceleration.
    - Types of forces, its units and Weight calculation.
    - Revision & Test , Power and roots Factor, Power base exponents number. Multiplication and division of power and root of a number. Square root of number and problems.

- Heat & temperature, thermometric scales, their conversions.
- Work energy and power, their units and applied problems.
- Percentage, changing percentage to decimal and fraction and vice versa. Applied problems.
- Problem on percentage related to trade.
- Different types of loads, stress, strain, modulus of elasticity. Ultimate strength, different types of stress, factor of safety, examples.
- Ratio & proportion- Ratio, finding forms ratio proportions, direct proportion and indirect proportion. Application of ratio and proportion & related problems.

53. **Engineering Drawing** :

- Engineering Drawing - introduction to Engg. Drawing and its importance.
- Use of drawing instruments –Drawing of straight, inclined and curved lines.
- Exercise on linear and angular measurements.
- Types of lines their meaning & application as per BIS SP: 46-2003.
- Simple conventional symbols for material and parts as per BIS SP: 46-2003. , Geometrical construction of rectangles, square, circles.
- Geometrical construction of polygon and ellipse, parabola & hyperbola.
- Geometrical construction of involutes, oval, and helix.
- Free hand sketching of straight lines, rectangles, circles, square, polygons, ellipse.
- Standard printing style for letters and numbers as per BIS : SP: 46-2003 using stencils
- Free hand sketching of simple geometrical solids, cube, cone, prism, cylinder, sphere, pyramids.
- Scales- Types & its use.
- Revision & Test, Construction of diagonal scale.
- Simple dimensioning technique, size and location, dimensions of parts, holes angles, taper, screw etc. as per BIS SP: 46-2003.
- Transferring measurements for linear, angular, circular dimensions form the given object to the related free hand sketches using different measuring instruments.
- Pictorial drawings, isometric drawings of simple geometrical solids.
- Oblique/orthographic projection of simple geometrical solids.
- Orthographic drawings: Application of both the first angle and third angle. Isometric drawing of simple machined & casting blocks.
- Free hand sketches of trade related hand tools and measuring tools

Note: The above syllabus is indicative and the questions in the test may include similar other topics pertaining to the level and content of essential qualification.