**MAHARASHTRA STATE BOARD OF VOCATIONAL EDUCATION EXAMINATION, MUMBAI**

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| 1 | Name of Syllabus | **C.C. in Fabrication and Designing of Steel Structure of Process Plant (307114)** |
| 2 | Max. Nos of Student | 25 Students |
| 3 | Duration | 6 Months |
| 4 | Type | Full Time |
| 5 | Nos Of Days / Week | 6 Days |
| 6 | Nos Of Hours /Days | 7 Hrs |
| 7 | Space Required | Laboratory = 1000 Sq feet<br>Class Room = 200 Sq feet<br>TOTAL = 1200 Sq feet |
| 8 | Entry Qualification | S.S.C. + any course pass from Chemical group of MSBVEE |
| 9 | Objective Of Syllabus/ introduction | 1. Awareness of Safety precautions<br>2. Knowledge of Engineering skill, use of tools in assembly<br>3. Awareness of Steel structure in Chemical Plant.<br>4. Awareness of Fabrication & Designing, Maintenance of Steel Plant<br>5. Awareness of Basic Fitting, Turning & Machining. |
| 10 | Employment Opportunity | The trainee will either to be able to take up jobs with agencies which Develop, Maintain, Repair, Fabrication and Designing of Steel Structure. Work as or with working experience will be in a position to start his own independent Business. |
| 11 | Teacher's Qualification | Diploma/Certificate in concern subject |
| 12 | Training System | **Training System Per Week** |

| Theory | Practical | Total |
|---|---|---|
| 12 Hours | 30 Hours | 42 Hours |

13 Exam. System

| Sr. No. | Paper Code | Name of Subject | TH/PR | Hours | Max. Marks | Min. Marks |
|---|---|---|---|---|---|---|
| 1 | **30711411** | Fabrication and Designing of Steel Structure | TH I | 3 hrs | 100 | 35 |
| 2 | **30711421** | Basic Fitting, Turning & Machining. | PR I | 3 hrs | 100 | 50 |
| 3 | **30711422** | Fabrication and Designing of Steel Structure | PR II | 6 hrs | 200 | 100 |
| | | **TOTAL** | | | **400** | **185** |

**FABRICATION & DESIGNING OF STEEL STRUCTURE**

| Practical - II | Theory - I |
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| Familiarization with the machinery/hand tools<br>used in the trade.<br>Introduction to safety equipment and their use.<br>Handling of measuring instruments – Steel tape, Vernier<br>Caliper, Sprit level, Micrometer. Try square, Height gauge,<br>Marking blocks, Bevel protractor etc.<br>Practice on marking various shapes on sheet metals.<br>Development practice of surface of prism, cylinder,<br>pyramids, cones, etc. | Outline of the subjects to be covered.<br>Role of fabrication in industry.<br>Basic Trigonometric calculations- Marking of Angles,<br>Triangles, Square, Rectangle, Parallelogram,<br>Hexagon, Octagon and Circles.<br>Calculation of volume and surface area of<br>rectangular prism, cubes and cylinders.<br>Development of right solids, prisms, cylinders,<br>pyramids, cones, frustum of pyramid, cone etc. |
| Weld joint preparation for fillet welds (cutting to size, fit up,<br>tack weld etc).<br>Fillet, Lap and T joint on MS flat by SMAW, position-1F<br>Fillet, Lap and T joint on MS flat by SMAW, position-2F<br>Inspection & clearance using LPI testing, Fillet, Lap and<br>T joint on MS flat by SMAW, position-3F, Fillet, Lap and<br>T joint on MS flat by SMAW, position-4F<br>Inspection & cleaning using LPI testing<br>Welding joint preparation for pipe fillet welding<br>Pipe to plate fillet weld flange joint on MS by SMAW,<br>position-5F | Basic Electricity applicable to welding<br>Arc welding power source AC/DC-advantages and<br>disadvantages<br>Type of metal and their characteristics<br>Classification of steel and their weldability<br>Heat affected zone and requirement for pre-heating<br>and maintaining inter pass temperature<br>Welding symbols and their importance<br>Welding positions and necessity of positional<br>welding, Weld joint edge preparation<br>Welding procedure and techniques- Track welding,<br>root run welding, intermediate and cover pass<br>welding, cleaning, checking etc.<br>Welding tools and accessories<br>Arc and its characteristics, Polarity types and |

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| Pipe to pipe fillet weld on MS pipes by SMAW, position-5F | application and Arc length<br>Welding fixtures and clamps<br>Coated electrodes- Types, description and coding as per BIS, AWS etc. Standard size and length of electrodes, Selection of electrodes and coating factor, Electrode storage and necessity of backing<br>Effect of heat on weldments<br>Welding distortion and stresses<br>Methods of controlling distortion by various methods<br>Methods of relieving stress on Weldments<br>Advantages of welded structures over riveted structures. |
| Gas cutting of M.S. Plates<br>Angle cutting of plates for required bevel angle by Pug<br>cutting machine<br>Practice on Plasma cutting system | Gas welding principles and application<br>Types of flames and their used<br>Gas cutting-straight line and profile<br>Gas cutting-Free hand, guided and mechanical<br>Manual Metal Arc cutting and gouging<br>Carbon Arc cutting and gouging |
| Identification of metals, bars, plates, flats, channels,<br>I section, T section, and box section etc.<br>Study of design drawing related to structural and pressure<br>parts and preparation of fitting square. | Metals used in fabrication'<br>Types of fabrication joints<br>Types and classification of steel and application<br>Framed structures-shell structure-Rolled sections, I section, channel section, angle section, T-section<br>Welding symbols<br>Structural/Pressure vessel design drawing reading and understanding the concepts. |
| Using guillotine sheering machine, marking and cutting of<br>sheet metals to required size. | Description and operation of croppers, shearing machine, Guillotine shears, punching machines, Edge planning machine and nibbling machine etc. |

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| Practice on bending of plates and pipes to required shape<br><br>Straightening plates and section<br><br>Edge planning as per requirement | Description and operation of straightening machines<br><br>Methods of bending plates, angle iron etc.<br><br>Cold bending and hot bending etc<br><br>Bending of angles and channels<br><br>Press work<br><br>Flame straightening methods |
| Double ’V’ butt joint on MS Flats in dissimilar thickness and<br><br>down hand positions by SMAW.<br><br>Root Inspection<br><br>Back Gouging<br><br>Adopting weld sequence for controlling distortion | Welding defects causes and remedy<br><br>Procedure of rectifying, weld defects-Gouging<br><br>methods/grinding, testing with die penetrate, pre<br><br>heating and re-welding |
| Setting up DC TIG welding equipment and making beading<br><br>practice on MSD in down hand position<br><br>Square butt joint on M.S. sheet by TIG welding in down<br><br>hand position<br><br>Root pass welding by TIG & LPI testing<br><br>Fule preparation single ’V’ butt on MS flat by TIG & SMAW<br><br>position 1G&2G | TIG Welding equipments<br><br>Advantages of TIG Welding process<br><br>Poser source types AC/DC<br><br>Types of polarity and application<br><br>Accessories-HF unit and DC Suppressor<br><br>Tungsten electrode, types, sizes and uses<br><br>Types of shielding gases |
| Preparation of pipe joint for high pressure pipe welding<br><br>Pipe welding- preparation of edges-cleaning the joint<br><br>surface-fit up the pipes<br><br>Tack weld two pipes together<br><br>Pipe work-cutting-bending-threading-joining and assembly<br><br>Pipe elbow & T joints on MS pipes by SMAW | Pipe and pipe- pipe schedule- types-methods of<br><br>bending-use of bending fixture-pipe bending<br><br>machine-use of pipe cutter, pipe wrenches-pipe<br><br>vices-pipe threads-pipe dies and taps etc<br><br>Edge preparation for pressure line pipes- Fit up<br><br>procedure<br><br>Riveting-types of riveting |

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| in flat position<br>Preparation of pipes for T,Y,K joints.<br>Preparation of single riveted lap joint<br>Double riveted lap joint<br>Single cover plate riveted butt joint<br>Double cover plate riveted butt joint | Hand riveting., cold and hot- methods of riveting –<br>use of pneumatic riveting, hydraulic rivetingchecking<br>rivets-removing of bad rivets<br>Types of bolts-black bolt, turned bolt, high strength<br>bolt etc. and their application |
| Practice on CO2 welding and Flux Cored Arc Welding<br>Practice on Automatic Submerged Arc Welding machine | Introduction to MIG/Flux cored arc welding –<br>Advantages-power source-wire feeder-electrode wires<br>shielding gases-types of metal transfer and welding<br>parameters<br>Introduction to Submerged arc welding (SAW).<br>Advantage, limitation equipment and operating<br>condition. |
| Bolted joints<br>Marking gusset plates<br>Marking joint section beam<br>Marking joint column using height gauge<br>Marking curved and bend plates and section<br>Marking on built up I section<br>Usage of pantograph for marking | Kind of structures- column base, plate girders,<br>Gantry girder, root trusses-description, types and<br>use<br>Beam connection,. Beam to column connectionframed<br>connection and seated connection<br>Type of pressure vessels – Boilers, Heat<br>exchangers, High pressure pipe lines etc.<br>Marking – Marking for cutting to size, marking for<br>beveling and chamfering and marking for pipes and<br>intersection |
| Preparation of single & double riveted lap & butt joint<br>Making simple riveted plate assembly Girder, trusses<br>Making a simple lattice structure<br>Making pressure pipe line assembly | Assembly- Procedure and technique for assembly<br>Assembling of riveted plates, girders and trusses<br>Assembly of welded I section<br>Assembly of cylindrical tanks including fitting and<br>lining of vessels |

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| Making welded I se4ction assembly<br><br>Making cylindrical tanks | |
| Making templates for cutting to size and simple objects<br><br>Making templates for Gussets and joint sections<br><br>Making simple fixture | Jigs and Template making-Design and description<br><br>for templates for cutting-templates of gussetstemplates<br><br>for marking angle<br><br>Template for marking joint section<br><br>Design and development for jigs for drilling and<br><br>angles<br><br>Design of simple fixture and clamping devices |
| Manufacturing of simple structures with L angles, I section<br><br>and channel sections using welding fixture by SMAW<br><br>Correction distortion by cold/hot method<br><br>Manufacturing of I-section using M.S. Flat by SMAW<br><br>Adapting skip welding/back step welding method for<br><br>controlling distortion<br><br>Preparation of WPS & PQR<br><br>Weld test specimen-preparation as per a standard<br><br>Inspection & testing | Types fo welding defects, cause and remedy<br><br>Inspection and testing of weldments<br><br>Visual Inspection kits and Gauges<br><br>Non-destructive testing methods<br><br>Structural welding codes and standards<br><br>Writing procedure for WPS and PQR<br><br>Requirement for qualification in different codes<br><br>Qualification procedure und3er various codes<br><br>Different tests and inspection involved in<br><br>qualification |
| Review and ALL INDIA TRADE TEST etc | Review and ALL INDIA TRADE TEST etc |

**Tool & Equipments**

| Sr. No | Name of Item | Quantity |
|---|---|---|
| **1** | ‘C’ Clamp 150 mm | **4** |
| **2** | Anvil Face Stake | **4** |
| **3** | Bessing Mallet | **4** |
| **4** | Chisel cold flat 25 mm x 250 mm | **4** |
| **5** | Crow bar 910 x 25 mm | **4** |
| **6** | D.E. Sammer G.P(6mm to 32 mm) (set of 12 spanner) | **4** |
| **7** | End faked Mallet | **4** |
| **8** | File flat 250 mm second cut and smooth | **4** |
| **9** | File Flat 250 mm smooth | **4** |
| **10** | File flat 300 mm bastard | **4** |
| **11** | File half round 300 mm smooth | **4** |
| **12** | Funnel Stake | **4** |
| **13** | Pneumatic rivet gun | **4** |
| **14** | Grip Wrench 200 mm | **4** |
| **15** | H.S.S. Twist Drill 3 mm & 6 mm (Parallel Shank | **4** |
| **16** | Hacksaw frame 300 mm adjustable (tubular) | **4** |
| **17** | Half Moon Stake | **4** |
| **18** | Hammer Block with handle | **4** |
| **19** | Hammer Creasing with handle | **4** |
| **20** | Hammer Peaning with handle | **4** |
| **21** | Hand Drill 0 to 6 mm, 8 mm, | **4** |
| **22** | Ladle 150 mm dia | **4** |
| **23** | Lazy Tong | **4** |
| **24** | Left cut snips 250 mm | **4** |
| **25** | Micrometer outside (0 to 25mm) | **4** |
| **26** | Portable Electric drill (Single phase | **4** |
| **27** | Punch Letter 4 mm and Punch Number 4 mm | **4** |

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| **28** | Vernier caliper (0mm-150mm) | **4** |
| **29** | Plier Combination 150 mm | **4** |
| **30** | Soldering copper Hatchet type 500 gms | **4** |
| **31** | Square File 2nd Cut 250 mm | **4** |
| **32** | Stake Round and Bottom | **4** |
| **33** | Steel Rule 600 mm | **4** |
| **34** | Steel Square 450mm x 600 mm | **4** |
| **35** | Tongs, close mouth and pick up(1each | **4** |
| **36** | Tongs, close mouth and pick up(1each | **4** |
| **37** | Triangular File Smooth 250 mm | **4** |
| **38** | Trowel small | **4** |

**Practical: - Basic Fitting, Turning & Machining**

| *Topic* | *Practical - I* |
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| **Basic Fitting, Turning & Machining.** | Physical introduction to measuring instruments- Handling of Instruments- Exercise in the use of liner measuring instruments Such as steel rule of different ranges. Out side calipers, in side Calipers for measuring inside. Outside measurement, in side measurement, depth gauge. |
| | Measurement of flat rectangular objects, cylindrical objects. Hollow components, threaded components. Exercises on external & internal measurements using micrometers & Height gauges |
| | Introduction to safety including fire equipments & their uses. Familiarize with Fitter's hand tools. Filling a flat surface of mild steel & cast iron. Check for flatness straightness & square ness. |
| | Simple blue print reading. Mark out according to simple to simple blue print. Hack sawing to dimension. Filing flat & square to size to an accuracy of +0.1mm. Marking & punching of stepped & angular components & finishing of stepped & angular components & finishing the part to the required shape & size to an accuracy of +0.1mm. |
| | Exercise on angular measurement using combination set & vernier bevel protector. Center drilling, reaming, counter sinking, counter boring and tapping for various sizes of mild steel and tapping on various size of mild steel material. |
| | Fitting exercise-simple to complex (Involving drilling, tapping, reaming, counter boring & slide fitting). |
| | Introduction to the trade area & the type of jobs made by the trainees in the workshop. Safety on handling tools & equipment related to the trade. Setting up of arc & gas apparatus. Lighting & adjustment of oxyacetylene flame & fusion runs with & without filter rode on 2 to 3 mm thick M.S sheet(in flat position in gas) . Striking & maintaining of arc & drawing shot heads of M.S. plate 10 to 12 mm thick (in flat position in arc). |
| | Lap, fillet & fillet joints on MS sheet 3mm in flat position (gas). Oxyacetylene cutting hand & machine square & level on 12 mm MS plate. Brazing on MS & Copper. |
| | Manufacturing process and their importance in Industries. Safety precautions followed on shop floor Vernier caliper and micro-meter, construction, parts, principles, application making the jobs. Different types cutting tools, grinding practice on pedestal machine. |
| | Introduction of shaping, planning and slotting- construction, types, parts, function and used, shaping rectangular block as per sketch. |
| | Introduction to milling machine demonstration on working principle, setting of jobs, setting of cutter in arbor setting of vice on table. Step milling using side and face cutter checking with micro-meter. Slot Mill using slot milling cutter. Face mill using face milling cutter. |
| | Setting of indexing head on milling, table and mill a hexagon on a round bar using direct indexing method. Spur gear cutting on horizontal milling machine using simple indexing methods. Checking with gear tooth Vernier calipers. Milling a rack by linear indexing method |

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| | Introduction of engine lathe and parts, holding the job in three & four jaw chuck. Facing and plain turning operations use of measuring tools required for turning. |
| | Facing, Plain and Turning. Taper Turning by compound rest slide methods. Setting threading tool and cutting the external "V" threads. |
| | Perform centre drilling, boring, parting off, Knurling, grooving, chamfering operations. |
| | Balancing and truing of grinding wheel. Mounting and dressing of grinding wheel. Re sharpen of plain turning tool on Pedestal grinder to an accuracy of one degree; check the tool angle using bevel protector. |

**LIST OF TOOLS AND EQUIPMENTS**

| Sr. | Particulars | Quantity |
|---|---|---|
| 1 | 2 | 3 |
| 1 | Measuring tape 3 meter | 16 |
| 2 | Inside spring caliper 200 mm | 16 |
| 3 | Outside spring caliper 200 mm | 16 |
| 4 | Ball pin Hammer - 200 gm | 16 |
| 5 | Fix spanner 23 mm set 9 spanner | 16 |
| 6 | Ring spanner 6 to 23 mm | 16 |
| 7 | Chisel cold flat 20x150 mm | 16 |
| 8 | Steal scale 300 mm engineering | 16 |
| 9 | Try square 200 mm | 16 |
| 10 | Screw driver 300 mm | 16 |
| 11 | Centre punch 100 mm x 100 mm | 16 |
| 12 | Scriber 150 mm | 16 |
| 13 | Bradawl 200 mm | 16 |
| 14 | Odd leg caliper spring type 200 mm | 16 |
| 15 | Out side spring caliper 400 mm | 02 |
| 16 | Inside spring caliper 400 mm | 02 |
| 17 | Ball pin hammer 400 gm | 04 |
| 18 | Flat chisel cold 25 x 200 mm | 02 |
| 19 | Cross cut chisel 150 mm | 02 |
| 20 | Sledge hammer 2 kg | 01 |
| 21 | Cross pin hammer 400 gm | 02 |
| 22 | Mallet | 02 |
| 23 | Teflon hammer | 01 |
| 24 | Vernier caliper 200 mm digital type | 01 |
| 25 | Vernier caliper 150 mm digital type | 01 |
| 26 | Micrometer 0-25 mm | 01 |
| 27 | Depth meter 0-300 mm | 01 |
| 28 | Slip gauge set | 01 |
| 29 | Feeler gauge leaf type 26 blades eng. & metric | 02 |
| 30 | Radius gauge leaf type 1to 15 mm | 01 |
| 31 | Digi matic thickness gauge | 01 |
| 32 | Universal Bevel protector | 01 |
| 33 | Pipe wrench 200 mm | 02 |
| 34 | Pipe wrench 300 mm | 02 |
| 35 | Adjustable wrench 250 mm | 02 |

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| 36 | Combination pliers 200 mm | 08 |
| 37 | Long nose pliers 200 mm | 04 |
| 38 | Flat file bastard 250 mm | 08 |
| 39 | Flat file smooth 250 mm | 08 |
| 40 | Flat file rough cut 250 mm | 04 |
| 41 | Flat file rough cut 300 mm | 08 |
| 42 | Half round file smooth - 250 mm | 04 |
| 43 | Half round file rough - 250 mm | 04 |
| 44 | Round file smooth - 200 mm | 04 |
| 45 | Round file Smooth - 200 mm | 04 |
| 46 | Triangular file - 150 mm | 04 |
| 47 | Square file - 200 mm | 04 |
| 48 | Needle file set | 04 |
| 49 | Allen key 12,14,15,16,18,20,22 mm | 02 each |
| 50 | Ring spanner 25x28, 24x26 | 02 each |
| 51 | Torque wrench | 01 |
| 52 | Tap set B S W | 01 |
| 53 | Die set B S W | 01 |
| 54 | Box spanner socket set 12.7 mm square drive hexagonal sockets set of size 10,11,12,13,14,15,16, 17,18,19, 21, 22,23,24,26,27,28,29,30,32,33,34 with accessories | 02 |
| 55 | Anvil big size | 01 |
| 56 | Surface plate 400x400 mm | 01 |
| 57 | 'V' Block | 02 |
| 58 | Hack saw frame adjustable 300 mm | 08 |
| 59 | Grease gun | 02 |
| 60 | Oil cane 500 ml | 02 |
| 61 | Screw Driver 400 mm | 02 |
| 62 | Screw Driver 300 mm | 02 |
| 63 | Try square 300 mm | 02 |
| 64 | Tap set metric | 01 |