

# **SYLLABUS**

**FOR THE TRADE OF**

**FORGER & HEAT TREATER**  
**Trade Technology Module -I**

**UNDER**

*CRAFT INSTRUCTOR'S TRAINING SCHEME*

**DESIGNED BY**  
**GOVERNMENT OF INDIA**  
**MINISTRY OF LABOUR(DGE&T)**  
**CENTRAL TRAINING INSTITUTE**  
**#10,ALANDUR ROAD**  
**GUINDY CHENNAI -600032**

## **GENERAL INFORMATION**

**1. NAME OF THE TRADE: FORGER AND HEAT TREATER**

**2. DURATION: 3 MONTHS**  
**Module I- Trade Technology,**

**3. ENTRY QUALIFICATION: NTC With 2 year  
Industrial experience Or  
NAC With 1 year Industrial experience  
in FORGER AND HEAT TREATER trade  
Or  
Passed Diploma in Mechanical Engg.  
1 year Industrial experience  
Or  
Passed Degree in mechanical or other relevant  
field**

**4. WORKSHOP SPACE: 102 Sq.mtr.**

**MEMBERS OF THE TRADE COMMITTEE  
FOR THE TRADE OF  
FORGER AND HEAT TREATER**

**MEMBERS**

1. Shri.D. VIJAYAKUMAR.  
JD / Principal, Chairman. CTII, Guindy,  
Chennai.600 032.
2. Shri.MS Balakrishnan.  
DD / Vice-Principal CTII, Guindy,  
Chennai.600 032.
3. Shri.SC Deogam,  
Assistant Director of Training. CTII, Guindy,  
Chennai - 600 032.
4. Shri.M. Kumaravel,  
Assistant Director of Training. ATI, Guindy,  
Chennai.600 032.
5. Shri.KV Ramakrishnan  
Training Officer CTII, Guindy,  
Chennai. 600 032.
6. Shri.S. Chockalingam  
Vocational Instructor (FM) CTII, Guindy,  
Chennai. 600 032.
7. Shri.T.L.Ravikumar.  
Vocational Instructor,  
(PATTERN MAKER / CARPENTER) ) CTII, Guindy,  
Chennai.600 032.
8. Shri. M.sunthramurthy,  
Vocational Instructor. Drawing. CTII. Guindy,  
Chennai.600 032.
9. Shri. S.Jawhar.  
Vocational Instructor. Arithmetic CTII.Guindy,  
Chennai.600 032.
10. Shri.R. Vasudevan  
Rtd.Training Officer. RDAT,Guindy.  
Chennai
11. Shri. P.A. Jayaraman.  
Dy.general Manager. India Piston Ring Blank Unit.  
Marai malai nager, kanchipuram.
12. Shri.B. Ramprakash  
Vice Chairman ISNT, Chennai Chapter  
Guindy, Chennai.
13. Shri.T.N. Ramaswamy  
Foundry Technical Consultant Sr. Executive Engineer (Rtd.) M/s.  
Addition & Co. Ltd., Chennai.

14. Shri.PS.Viswanathan,  
Training Manager (Rtd.) M/s. Ashok Leyland,  
Chennai.
15. Shri.Dr. N.Rangaswamy, Ph.D.,  
Director Institute of Knowledge Potential  
Management, Chennai.
16. Shri.K.Srinivasan,  
Welding Consultant Aarthi Engineering & Consultant,  
Chennai.
17. Shri.S. Palanivelu,  
Dy.Manager Technical & Corporate. Metro pollution Transports  
Corporation, Chennai.
18. Shri.T.Ganesan  
Rtd. Section Manager (Foundry) Binny Engineering Pvt. Ltd.,  
Chennai
19. Shri.R.Veeraraghavan  
Sr. Manager, Metallurgical Addison & Co Pvt. Ltd., Chennai
20. Shri.P.Solomon  
Asst. Training Officer, F.H.T/ Fitter Govt. ITI (N), Chennai.
21. Shri.K. Manisekar  
Asst. Prof. HOD,  
Mechanical Department Vel Tech high tech Dr. Rangarajan  
Dr.Sagunthala Engg.College.  
Avadi, Chennai.
22. Shri.E. Baskaran,  
Workshop Instructor Murugappa Poly Technique Avadi,  
Chennai
23. Shri.R. Raguraj  
Asst. Training Officer (FM) Govt. ITI, Madurai
24. Shri.K. Thiruvencatam  
Asst. Trg. Officer (PM) Govt. ITI (N), Chennai.
25. Shri.S. Baskaran  
Junction Training Officer (FM) Govt. ITI (N), Chennai.
26. Shri.Thirumalai Kumar  
Jn. Training Officer Govt. ITI, Dharapuram.
27. Shri.S. Baskaran.  
Skilled Aritician(Foundry) AKMT Polytechnic,  
Chennai.
28. Shri.P.Solomon  
Asst. Training Officer, F.H.T/ Fitter Govt. ITI (N), Chennai.

## DRAFT SYLLABUS FOR CRAFT INSTRUCTOR

**TRADE: FORGER AND HEAT TREATER**

**Trade Technology Module –I**

**Duration: 3months**

<b>We ek No</b>	<b>Ex. No.</b>	<b>Practical</b>	<b>Theory</b>
<b>1</b>	<b>1</b>	<b>Introduction to craftsmen training course and importance of craftsmen training in India. Familiarization with the institute. Importance of trade training machinery used in the trade as well as industries</b>	<b>General discipline in the institute Elementary first aids importance of forger &amp; heat treated in industry. Introduction metallurgy and mechanical property of metals.</b>
<b>2</b>	<b>2</b>	<b>Exercise on upsetting, drawing out, forge welding, punching and piercing hole with an accuracy of 1.0mm in hand forging .</b>	<b>Description of work of other workshop trades such as turner, miller, fitter, grinder, shaper, slotter, planer, welder and sheet metal worker as it relates to the forging and heat treatment.</b>
<b>3</b>	<b>3</b>	<b>Hand forging of item of agricultural implements and hand tools.</b>	<b>Description care maintenance of hand tools and equipment used in agriculture and industries.</b>
<b>4</b>	<b>4</b>	<b>Fabricating small cylindrical cans, buckets, rectangular containers form sheet metals.</b>	<b>Simple joints and operations used in sheet metal work.</b>
<b>5</b>	<b>5</b>	<b>Soldering and joining of ferrous and non ferrous components (soft hard) . Brazing the tools tips with holder.</b>	<b>Soldering –brazing process type's composition of solder spelters fluxes uses and their effects. Composition and melting temperature of some filter metals used in soldering.</b>
<b>6</b>	<b>6</b>	<b>Making of coil spring and tempering –bending of steel pipes and strips to different radius and angles. - Making set of leaf spring and tempering.</b>	<b>Spring steel –composition , properties ,uses ,method of making coil spring –repairing – calculating the material required for making spring method of making of leaf spring and calculation of material required .</b>
<b>7</b>	<b>7</b>	<b>Assembling of male and female fitting –Assembling parts by riveting so as to make complete unit according to drawing.</b>	<b>Equipment and tools used in fitting shop riveting -types – method.</b>

8	8	Studying of the operations, setting up of the dies fixtures and handling mechanism of-Pneumatic power hammer –Steam hammer – Drop hammer (Board and belt type)-Hydraulic presses –Screw presses-Trimming presses-Friction pulley type hammers –Horizontal forging machines and their care and maintenance –Studying of forging dies(Top and bottom dies) flesh gutters. Blockers of mould impression and final (Mully) Impression dies and die maintenance and draft angles.	Pneumatic –steam hammers – hydracilic press forging tools fixture ancillary tools operations performed on power hammers. Horizontal and automatic forging processes.
9	9	Forge the following exercises with the help of forging machines – Lever double eye –Bell crank lever (Stamping)-Double ended spanner (Stamping) –Cone cutting rod – Locking bar –Reversing shaft – Cross beam –Lever.	Drop forging and embossing board's type's fraction drop hammer chain drop hammer tools and fixture for drop forging pre –forging process, flash trimming process, preliminary final multiple impression.
10	10	Studying of defects in forging unfailing ,pitting burning, surface cracks axial cracks and remedies suggested etc.	Study of forging defects-fabrication defects –heat treatment defects etc.
11	11	Studying of allowances for forging tolerance on for forged components shrinkage allowances for different steels and Ferrous & Non ferrous.-A chart is to be prepared it is to be verified by actually measuring the components dimensions. – Preparation of forging temperature charts for various steels. The burning when the temperature over shoot	Allowances for forging –heat loss allowance of scale loss allowance –cutting allowance end bet allowance –matching allowance precaution should be observed white working on high carbon steel. Method of equalizing temperature to avoid burning of steel. Forging high speed steel tools used – precautions to be followed.
12	12	<u>1<sup>st</sup> phase Examination practical</u>	<u>1<sup>st</sup> phase Examination theory.</u>

**LIST OF TOOLS AND EQUIPMENT  
FOR A BATCH OF 10 Trainees  
Trade : Forging and Heat Treatment Module I & II**

<b>Sl. No.</b>	<b>Item</b>	<b>For Instructor</b>	<b>For Trainees</b>
<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
	<b>TRAINEES TOOL KIT</b>		
1.	Goggles	1	10 Pairs
2.	Gloves	1	10 Pairs
3.	Apron leather 106 cm	1	10 Pairs
4.	Blacksmiths safety boots	1	10 Pairs
	<b>SHOP OUTFIT PER UNIT</b>	1	5 Pairs
5.	Brass Rule 300 mm	1	5 Pairs
6.	Calipers outside 20 cm	1	5 Pairs
7.	Calipers inside 20 cm	1	5 Pairs
8.	Compass wing 20 cm	1	5 Pairs
9.	Smith square 45 cm x 30 cm	1	5 Pairs
10.	File flat rough 35 cm double cut	1	5 Pairs
11.	File half round rough 25 cm	1	5 Pairs
12.	File square rough 25 cm	1	5 Pairs
13.	File triangular rough 20 cm	1	5 Pairs
14.	Hardia or bottom sit for anvil 5 cm	1	3 Nos.
15.	Tong bolt 300, 500, 1000, 1500 mm	1	4 each
16.	Tong side 300, 600, 1000, 1500 mm	1	4 each
17.	Tong flat 300, 500, 1000, 1500 mm	1	4 each
18.	Tong round 300, 500, 1000, 1500 mm	1	4 each
19.	Tong hollow bit 300, 500, 1000, 1500 mm	1	4 each
20.	Set cold roded	1	8 Nos.
21.	Chisel cold flat 2.5 x 20 cm	1	8 Nos.
22.	Chisel cold flat 6 cm	1	8 Nos.
23.	Flatter roded 63mm square	1	4 Nos.
24.	Swage top 12 mm roded	1	4 Nos.
25.	Swage top 19 mm roded	1	4 Nos.

26.	Swage top 25 mm rodded	1	4 Nos.
27.	Fuller top rodded 6 mm	1	4 Nos.
26.	Fuller top rodded 12 mm	1	4 Nos.
27.	Fuller top rodded 19 mm	1	4 Nos.
28.	Fuller bottom 6 mm	1	4 Nos.
29.	Fuller bottom 12 mm	1	4 Nos.
30.	Fuller bottom 19 mm	1	4 Nos.
31.	Swage bolster 12 x 15 x 19 mm in set of 3	1	2 Sets
32.	Centre punch 10 cm	1	2 Nos.
33.	Punch round 19 to 38 mm x 6 mm raising by 6 mm	1	2 Sets
34.	Punch round 6 to 15 mm x 3 mm raising by 3 mm	1	2 Sets
35.	Punch oval 25 x 12 mm	1	4 Nos.
36.	Punch oval 25 x 38 mm	1	4 Nos.
37.	Punch oval 38 x 19 mm	1	4 Nos.
38.	Hammer smith 1.8 kg handled	1	4 Nos.
39.	Hammer smith 0.9 kg handled	1	4 Nos.
40.	Swage bottom 5 mm	1	4 Nos.
41.	Swage bottom 12 mm	1	4 Nos.
42.	Swage bottom 14 mm	1	4 Nos.
43.	Square mouth tong	1	4 Nos.
44.	Blacksmith's bending link	1	4 Nos.
45.	Blacksmith fork	1	
46.	Blacksmith's levelling block with holes and accessories for bending	1	1 No.
47.	Steel rule 30 cm	1	10 Nos.
48.	Try square engineers 15 cm	1	4 Nos.
49.	Hacksaw frame adjustable 30 cm	1	4 Nos.
50.	Hammer sledge 3.2 kg. double faced handled	1	4 Nos.
51.	Hammer sledge 6.3 kg. double faced handled	1	2 Nos.
52.	Hammer set 0.9 kg handled	1	4 Nos.
53.	Hammer set 1.8 kg handled	1	2 Nos.
54.	Rivet snap 9 and 12 mm set of two	1	2 Sets
55.	Goggles	1	2 pairs
56.	Poker	1	1 pair
57.	Shovel	1	4 Nos.

58.	B.S.W. taps and dies 6 to 12 mm by 1.5 mm with a set of suitable tap size drills	1	1 set
59.	Rake hand	1	2 Nos.
60.	Hot set rodded	1	2 Nos.
61.	Drill twist 3 to 12 mm by 1.5 mm set	1	1 set
62.	Tank, water 15 x 75 x 4 cm	1	10 Nos.
63.	Block sware 35 cm x 35 cm x 12	1	2 Nos.
64.	Leg vice 10 cm jaw	1	2 Nos.
65.	work bench 182 cm x 91 cm x 6 cm	1	4 Nos.
66.	Almirah 182 cm x 12 cm x 45 cm cast iron or stainless steel	1	1 No.
67.	Wheel barrow	1	1 No.
68.	Annealing box 25 x 10 x 25 cm	1	1 No.
69.	Metal rack 192 x 152 x 45 cm	1	1 No.
70.	Steel lockers with drawers (standard size)	1	2 Nos.
71.	Black board with easel	1	2 Nos.
72.	Fire extinguisher (Chemical types, Soda Ash, CO <sub>2</sub> type)	1	Each one
73.	Fire buckets	1	2 Nos.
74.	Anvil london pattern 150 Kg	1	4 Nos.
75.	Bench vice 15 cm jaw	1	3 Nos.
76.	Mallet wooden 0.66 kg.	1	6 Nos.
77.	Soldering copper 0.27 kg.	1	4 Nos.
78.	Protractor with blade	1	4 Nos.
79.	Tinman's square 45 cm x 60 cm	1	2 Nos.
80.	Standard sheet metal gauge	1	4 Nos.
81.	Stake ratchet	1	1 No.
82.	Stake round & bottom	1	4 Nos.
83.	Stake half moon	1	4 Nos.
84.	Funnel	1	4 Nos.
85.	Bick iron	1	4 Nos.
86.	Horse	1	2 Nos.
87.	Hammer greasing	1	4 Nos.
88.	Hammer plasting	1	4 Nos.
89.	Shear tinman's 30 cm	1	6 Nos.

90.	Snip straight	1	6 Nos.
91.	Snip bend	1	6 Nos.
92.	Hand shear universal	1	2 Nos.
93.	Punch round 4 mm	1	4 Nos.
94.	Rivert sets and snap combined 4mm	1	4 Nos.
95.	Rivert sets and snap combined 6mm	1	4 Nos.
96.	Groover 6 mm	1	4 Nos.
97.	Groover 4 mm	1	4 Nos.
98.	Blow lamp 4 pint	1	1 No.
99.	Blow lamp 1 pint	1	1 No.
100.	Drill hand 0 to 6 mm, 8 mm, 10 mm and 12 mm	1	2 Nos.
101.	Hammer raising 0.45 kg	1	2 Nos.
102.	Soldering iron 425 mm	1	4 Nos.
103.	Rawl punch holder and bits	1	2 Nos.
104.	Hand vice 5 cm No.1	1	2 Nos.
105.	Brush steel wire 5 cm x 15 cm No.1	1	4 Nos.
106.	Goves pairs for welding No.1	1	4 Nos.
107.	Trammel medium	1	1 No.
108.	Portable forge	1	2 Nos.
109.	Welding plant oxy-acetylene complete (High pressure) (To be provided where no welding trade exists)	1	1 No.

## **GENERAL INSTALLATIONS**

- |  |   |        |
|--|---|--------|
| 1. Forge with hood and chimney blowers forge capacity 1000 cft / min 15 cm water gauge pressure complete with electric motors, starter and switch with air pipe line cocks etc. complete set | - | 5 Nos. |
| 2. Blacksmith's cones 25 to 38 mm and 76 to 254 mm   | - | 2 Nos. |
| 3. Lever shear hand operated blade 30 cm   | - | 1 No.  |
| 4. Pipe bending machine manually operated  | - | 1 No.  |
| 5. Pneumatic hammer 50 kg. with accessories capacity 30 cm stroke motorised  | - | 1 No.  |
| 6. Pneumatic hammer 100 kg. with accessories capacity 50 cm stroke motorised   | - | 1 No.  |
| 7. Pillar type drilling machine 12 mm capacity   | - | 1 No.  |
| 8. Pedestal grinder with 20 cm wheels  | - | 1 No.  |
| 9. Oil fired furnace for forging 3 ft. x 3 ft. x 2½ heating range upto 1350 C.   | - | 1 No.  |
| 10. Electric furnace rating about 12 kW, 440 volt, 3 phase upto 1000C, 50 cycles chamber size 300 x 200 x 500 mm with automatic temperature pyrometers                                       | - | 1 No.  |
| 11. Oil Quenching tank 50 litres capacity  | - | 1 No.  |
| 12. Water tank for quenching capacity about 50 litres  | - | 1 No.  |
| 13. Alloy steel test pieces of known composition of atleast 15 different steel pieces.   | - | 1 No.  |
| 14. Shearing machine for cutting flat, square round bars and planes hand operated (any smaller make)   | - | 1 No.  |

SL. NO:	NAME OF EQUIPMENT	QUANTIT Y
15.	<p>Testing Of Mechanical Properties:  Tensile Tester,  Hardness Tester,  The brinell Tester,  The Rockwell Tester,  Fracture Tester,  Impact Tester,  Creep tester.</p> <p>Specification:  Equipments suitable for Training Purposes.</p>	Each one unit
16.	<p>NON- DESTRUCTIVE TEST:  Radiography, (X-ray &amp; y- ray)  Magnetic Particle Detector,  Dye Fluorescent –  Dye Penetrants Detector,  Ultrasonic Flaw Detector,</p> <p>Specification:  Equipments suitable for Training Purposes.</p>	Each one unit
17.	Metal Chemical Composition Analyzers.	Each one unit

# **SYLLABUS**

**FOR THE TRADE OF**

**FORGER & HEAT TREATER**  
**Trade Technology Module -II**

**UNDER**

*CRAFT INSTRUCTOR'S TRAINING SCHEME*

**DESIGNED BY**  
**GOVERNMENT OF INDIA**  
**MINISTRY OF LABOUR(DGE&T)**  
**CENTRAL TRAINING INSTITUTE**  
**#10,ALANDUR ROAD**  
**GUINDY CHENNAI -600032.**

## **GENERAL INFORMATION**

**1. NAME OF THE TRADE: FORGER AND HEAT  
TREATER**

**2. DURATION: 3 months**

**Module II- Trade Technology,**

**3. ENTRY QUALIFICATION: should have completed  
TT module I on**

**FORGER AND HEAT  
TREATER**

**4. WORKSHOP SPACE: 102Sq.mtr.**

# **GENERAL INFORMATION**

**1. NAME OF THE TRADE: FORGER & HEAT TREATER**

**2. DURATION: ONE YEAR**

**Module I- Trade Technology,**

**Module II-Trade Technology,**

**Module III-Engineering Technology,**

**Module IV-Training Methodology.**

**3. ENTRY QUALIFICATION: NTC With 2 year  
Industrial experience  
NAC With 1 year Industrial experience  
in FORGER & HEAT TRATER trade  
Or.**

**1 year Industrial experience  
Or**

**Passed Degree in mechanical or, other relevant  
field**

**WORKSHOP SPACE: 102Sq.mtr.**

**MEMBERS OF THE TRADE COMMITTEE  
FOR THE TRADE OF  
FORGER AND HEAT TREATER**

**MEMBERS**

1. Shri.D. VIJAYAKUMAR.  
JD / Principal, Chairman. CTII, Guindy,  
Chennai.600 032.
2. Shri.MS Balakrishnan.  
DD / Vice-Principal CTII, Guindy,  
Chennai.600 032.
3. Shri.SC Deogam,  
Assistant Director of Training. CTII, Guindy,  
Chennai - 600 032.
4. Shri.M. Kumaravel,  
Assistant Director of Training. ATI, Guindy,  
Chennai.600 032.
5. Shri.KV Ramakrishnan  
Training Officer CTII, Guindy,  
Chennai. 600 032.
6. Shri.S. Chockalingam  
Vocational Instructor (FM) CTII, Guindy,  
Chennai. 600 032.
7. Shri.T.L.Ravikumar.  
Vocational Instructor,  
(PATTERN MAKER / CARPENTER ) CTII, Guindy,  
Chennai.600 032.
8. Shri. M.sunthramurthy,  
Vocational Instructor. Drawing. CTII. Guindy,  
Chennai.600 032.
9. Shri. S.Jawhar.  
Vocational Instructor. Arithmetic CTII.Guindy,  
Chennai.600 032.
10. Shri.R. Vasudevan  
Rtd.Training Officer. RDAT,Guindy.  
Chennai
11. Shri. P.A. Jayaraman.  
Dy.general Manager. India Piston Ring Blank Unit.  
Marai malai nager, kanchipuram.
12. Shri.B. Ramprakash  
Vice Chairman ISNT, Chennai Chapter  
Guindy, Chennai.
13. Shri.T.N. Ramaswamy  
Foundry Technical Consultant Sr. Executive Engineer (Rtd.) M/s.  
Addition & Co. Ltd., Chennai.

- |     |  |   |
|-----|--|---|
| 14. | Shri.PS.Viswanathan,<br>Training Manager (Rtd.)                | M/s. Ashok Leyland,<br>Chennai.   |
| 15. | Shri.Dr. N.Rangaswamy, Ph.D.,<br>Director                      | Institute of Knowledge Potential<br>Management, Chennai.                            |
| 16. | Shri.K.Srinivasan,<br>Welding Consultant                       | Aarthi Engineering & Consultant,<br>Chennai.  |
| 17. | Shri.S. Palanivelu,<br>Dy.Manager Technical & Corporate.       | Metro pollution Transports<br>Corporation, Chennai.                                 |
| 18. | Shri.T.Ganesan<br>Rtd. Section Manager (Foundry)               | Binny Engineering Pvt. Ltd.,<br>Chennai   |
| 19. | Shri.R.Veeraraghavan<br>Sr. Manager, Metallurgical             | Addison & Co Pvt. Ltd., Chennai   |
| 20. | Shri.P.Solomon<br>Asst. Training Officer, F.H.T/ Fitter        | Govt. ITI (N), Chennai.   |
| 21. | Shri.K. Manisekar<br>Asst. Prof. HOD,<br>Mechanical Department | Vel Tech high tech Dr. Rangarajan<br>Dr.Sagunthala Engg.College.<br>Avadi, Chennai. |
| 22. | Shri.E. Baskaran,<br>Workshop Instructor                       | Murugappa Poly Technique Avadi,<br>Chennai  |
| 23. | Shri.R. Raguraj<br>Asst. Training Officer (FM)                 | Govt. ITI, Madurai  |
| 24. | Shri.K. Thiruvencatam<br>Asst. Trg. Officer (PM)               | Govt. ITI (N), Chennai.   |
| 25. | Shri.S. Baskaran<br>Junction Training Officer (FM)             | Govt. ITI (N), Chennai.   |
| 26. | Shri.Thirumalai Kumar<br>Jn. Training Officer                  | Govt. ITI, Dharapuram.  |
| 27. | Shri.S. Baskaran.<br>Skilled Aritician(Foundry)                | AKMT Polytechnic,<br>Chennai.   |
| 28. | Shri.P.Solomon<br>Asst. Training Officer, F.H.T/ Fitter        | Govt. ITI (N), Chennai.   |

# DRAFT SYLLABUS FOR CRAFT INSTRUCTOR

## TRADE: FORGER AND HEAT TREATER

Trade Technology Module –II

Duration: 3 months.

We ek No	Ex No	Practical	Theory
13	13	Revision of major Skill.	Revision of Previous Topics.
14	14	Studying of operation and maintenance of simple heat treatment furnace – muffle furnace –slat bath furnace – quenching media –properties – electrically –heated quenching bathes –heat treatment of forged components.	Construction of furnaces uses for heating steels for forging heating steel for forging temperature measuring instrument recoding of temperature
15	15	Case hardening exercise in-steel –carburizing cyaniding and nitrating ,flame hardening , induction hardening case hardening parts at different place in its cross section .	Need of heat treatment for cutting tools, hardening .Basic metallurgy relative to trade.
16	16	Hardening of steel exercise – hardening exercise at different temperature – different carbons contains hardness to be checked after every exercise. Tempering of hardened steel parts –exercise at temperature for varying carbon to be checked after every exercise. studying of temperature colors charts.	Iron carbon phase diagram for plain carbon steels –critical temperatures structure of ferrite- pearlite martensite austenite.
17	17	Annealing exercise –different exercise with steel of various carbons content exercise to be carried out at their corresponding annealing temperature –hardness of part to be checked before and after annealing.	Need of heat treatment for cutting – hardening and tempering of cutting by single heating and double heating method. Definition of annealing and normalizing different between the above.
18	18	Normalizing exercise –exercise on cast parts also bolster sets for press tools, various casting body of machine, the importance of normalizing .	Annealing –normalizing – hardening and tempering process for plain carbon steel .
19	19	Heat treatment of –Rolled steel – spring – wires – gears –steel casting – carbon and low alloy cutting tools – high speed cutting tools - dies for cold swaging and cold heading processes – hammer dies and die mould – Measuring gauges – Grey iron casting – High strength iron casting – Cooper , brasses and bronzes – Wrought aluminum alloy castings ..Magnesium alloy.	spring steel – composition – properties – use for method of making coil spring – repairing - calculating the material required for making spring method of making of making of leaf spring –and calculation of material required heat treatment of low alloy – steel –medium alloy steel and high alloy steel . Coil and leaf spring making and heat treatment – general repair work of chain – locks and tools .

20	20	Hardness testing, study of hardness testing , machines their working principle – study of standard hardened pieces . Hardness of different hardened jobs to be carried out	Testing of material – compressive test – tensile test – sharing and impact tests and hardness test methods test by fracture and cutting.
21	21	Inspection and acceptance – methods of forged and heat treated material – detection of micro –internal cracks – surface cracks – by non destructive testing methods .	Inspection – importance – instruments used- like calipers detection of defects – physical test and non –destructive test – surface finish and protection of surface – methods of surface finish processes and protection of finish surfaces .
22	22	Organizational set up of forge and heat treatment shop – the lay out of machine – furnace –quenching bath – store –room office room – organization chart and plantain machinery .	Shop lay out – organization set up of forging and heat treatment shop use of reference tables and trade hand books.
23	23	Project work (forge and heat treatment) working modal related trade.	Revision.
24.	24	Practice demonstration forge &heat treatment with the use of model /move up /training aids /actual job...2 <sup>nd</sup> phase examinations practice.	Assign study for preparation of FTT of craft 2 <sup>nd</sup> phase .2 <sup>nd</sup> phase examination theory .

**LIST OF TOOLS AND EQUIPMENT  
FOR A BATCH OF 10 Trainees  
Trade : Forging and Heat Treatment Module I & II**

Sl. No.	Item	For Instructor	For Trainees
1	2	3	4
	<b>TRAINEES TOOL KIT</b>		
1	Goggles	1	10 Pairs
2	Gloves	1	10 Pairs
3	Apron leather 106 cm	1	10 Pairs
4	Blacksmiths safety boots	1	10 Pairs
	<b>SHOP OUTFIT PER UNIT</b>	1	5 Pairs
6	Brass Rule 300 mm	1	5 Pairs
7	Calipers outside 20 cm	1	5 Pairs
8	Calipers inside 20 cm	1	5 Pairs
9	Compass wing 20 cm	1	5 Pairs
10	Smith square 45 cm x 30 cm	1	5 Pairs
11	File flat rough 35 cm double cut	1	5 Pairs
12	File half round rough 25 cm	1	5 Pairs
13	File square rough 25 cm	1	5 Pairs
14	File triangular rough 20 cm	1	5 Pairs
15	Hardia or bottom sit for anvil 5 cm	1	3 Nos.
16	Tong bolt 300, 500, 1000, 1500 mm	1	4 each
17	Tong side 300, 600, 1000, 1500 mm	1	4 each
18	Tong flat 300, 500, 1000, 1500 mm	1	4 each
19	Tong round 300, 500, 1000, 1500 mm	1	4 each
20	Tong hollow bit 300, 500, 1000, 1500 mm	1	4 each
21	Set cold roded	1	8 Nos.
22	Chisel cold flat 2.5 x 20 cm	1	8 Nos.
23	Chisel cold flat 6 cm	1	8 Nos.
24	Flatter roded 63mm square	1	4 Nos.
25	Swage top 12 mm roded	1	4 Nos.
26	Swage top 19 mm roded	1	4 Nos.

27	Swage top 25 mm rodded	1	4 Nos.
28	Fuller top rodded 6 mm	1	4 Nos.
29	Fuller top rodded 12 mm	1	4 Nos.
30	Fuller top rodded 19 mm	1	4 Nos.
31	Fuller bottom 6 mm	1	4 Nos.
32	Fuller bottom 12 mm	1	4 Nos.
33	Fuller bottom 19 mm	1	4 Nos.
34	Swage bolster 12 x 15 x 19 mm in set of 3	1	2 Sets
35	Centre punch 10 cm	1	2 Nos.
36	Punch round 19 to 38 mm x 6 mm raising by 6 mm	1	2 Sets
37	Punch round 6 to 15 mm x 3 mm raising by 3 mm	1	2 Sets
38	Punch oval 25 x 12 mm	1	4 Nos.
39	Punch oval 25 x 38 mm	1	4 Nos.
40	Punch oval 38 x 19 mm	1	4 Nos.
41	Hammer smith 1.8 kg handled	1	4 Nos.
42	Hammer smith 0.9 kg handled	1	4 Nos.
43	Swage bottom 5 mm	1	4 Nos.
44	Swage bottom 12 mm	1	4 Nos.
45	Swage bottom 14 mm	1	4 Nos.
46	Square mouth tong	1	4 Nos.
47	Blacksmith's bending link	1	4 Nos.
48	Blacksmith fork	1	
49	Blacksmith's levelling block with holes and accessories for bending	1	1 No.
50	Steel rule 30 cm	1	10 Nos.
51	Try square engineers 15 cm	1	4 Nos.
52	Hacksaw frame adjustable 30 cm	1	4 Nos.
53	Hammer sledge 3.2 kg. double faced handled	1	4 Nos.
54	Hammer sledge 6.3 kg. double faced handled	1	2 Nos.
55	Hammer set 0.9 kg handled	1	4 Nos.
56	Hammer set 1.8 kg handled	1	2 Nos.
57	Rivet snap 9 and 12 mm set of two	1	2 Sets
58	Goggles	1	2 pairs
59	Poker	1	1 pair
60	Shovel	1	4 Nos.

61	B.S.W. taps and dies 6 to 12 mm by 1.5 mm with a set of suitable tap size drills	1	1 set
62	Rake hand	1	2 Nos.
63	Hot set rodded	1	2 Nos.
64	Drill twist 3 to 12 mm by 1.5 mm set	1	1 set
65	Tank, water 15 x 75 x 4 cm	1	10 Nos.
66	Block sware 35 cm x 35 cm x 12	1	2 Nos.
67	Leg vice 10 cm jaw	1	2 Nos.
68	work bench 182 cm x 91 cm x 6 cm	1	4 Nos.
69	Almirah 182 cm x 12 cm x 45 cm cast iron or stainless steel	1	1 No.
70	Wheel barrow	1	1 No.
71	Annealing box 25 x 10 x 25 cm	1	1 No.
72	Metal rack 192 x 152 x 45 cm	1	1 No.
73	Steel lockers with drawers (standard size)	1	2 Nos.
74	Black board with easel	1	2 Nos.
75	Fire extinguisher (Chemical types, Soda Ash, CO <sub>2</sub> type)	1	Each one
76	Fire buckets	1	2 Nos.
77	Anvil london pattern 150 Kg	1	4 Nos.
78	Bench vice 15 cm jaw	1	3 Nos.
79	Mallet wooden 0.66 kg.	1	6 Nos.
80	Soldering copper 0.27 kg.	1	4 Nos.
81	Protractor with blade	1	4 Nos.
82	Tinman's square 45 cm x 60 cm	1	2 Nos.
83	Standard sheet metal gauge	1	4 Nos.
84	Stake ratchet	1	1 No.
85	Stake round & bottom	1	4 Nos.
86	Stake half moon	1	4 Nos.
87	Funnel	1	4 Nos.
88	Bick iron	1	4 Nos.
89	Horse	1	2 Nos.
90	Hammer greasing	1	4 Nos.
91	Hammer plasting	1	4 Nos.
92	Shear tinman's 30 cm	1	6 Nos.

93	Snip straight	1	6 Nos.
94	Snip bend	1	6 Nos.
95	Hand shear universal	1	2 Nos.
96	Punch round 4 mm	1	4 Nos.
97	Rivert sets and snap combined 4mm	1	4 Nos.
98	Rivert sets and snap combined 6mm	1	4 Nos.
99	Groover 6 mm	1	4 Nos.
100	Groover 4 mm	1	4 Nos.
101	Blow lamp 4 pint	1	1 No.
102	Blow lamp 1 pint	1	1 No.
103	Drill hand 0 to 6 mm, 8 mm, 10 mm and 12 mm	1	2 Nos.
104	Hammer raising 0.45 kg	1	2 Nos.
105	Soldering iron 425 mm	1	4 Nos.
106	Rawl punch holder and bits	1	2 Nos.
107	Hand vice 5 cm No.1	1	2 Nos.
108	Brush steel wire 5 cm x 15 cm No.1	1	4 Nos.
109	Goves pairs for welding No.1	1	4 Nos.
110.	Trammel medium	1	1 No.
111.	Portable forge	1	2 Nos.
112	Welding plant oxy-acetylene complete (High pressure) (To be provided where no welding trade exists)	1	1 No.

## GENERAL INSTALLATIONS

1	Forge with hood and chimney blowers forge capacity 1000 cft / main 15 cm water gauge pressure complete with electric motors, starter and switch with air pipe line cocks etc. complete set	-	5 Nos.
2	Blacksmith's cones 25 to 38 mm and 76 to 254 mm	-	2 Nos.
3	Lever shear hand operated blade 30 cm	-	1 No.
4	Pipe bending machine manually operated	-	1 No.
5	Pneumatic hammer 50 kg. with accessories capacity 30 cm stroke motorised	-	1 No.
6	Pneumatic hammer 100 kg. with accessories capacity 50 cm stroke motorised	-	1 No.
7	Pillar type drilling machine 12 mm capacity	-	1 No.
8	Pedestal grinder with 20 cm wheels	-	1 No.
9	Oil fired furnace for forging 3 ft. x 3 ft. x 2½ heating range upto 1350 C.	-	1 No.
10	Electric furnace rating about 12 kW, 440 volt, 3 phase upto 1000C, 50 cycles chamber size 300 x 200 x 500 mm with automatic temperature pyrometers	-	1 No.
11	Oil Quenching tank 50 litres capacity	-	1 No.
12	Water tank for quenching capacity about 50 litres	-	1 No.
13	Alloy steel test pieces of known composition of atleast 15 different steel pieces.	-	1 No.
14	Shearing machine for cutting flat, square round bars and planes hand operated (any smaller make)	-	1 No.

SL. NO:	NAME OF EQUIPMENT	QUANTIT Y
15.	<p>Testing Of Mechanical Properties:  Tensile Tester,  Hardness Tester,  The brinell Tester,  The Rockwell Tester,  Fracture Tester,  Impact Tester,  Creep tester.</p> <p>Specification:  Equipments suitable for Training Purposes.</p>	Each one unit
16.	<p>NON- DESTRUCTIVE TEST:  Radiography, (X-ray &amp; y- ray)  Magnetic Particle Detector,  Dye Fluorescent –  Dye Penetrants Detector,  Ultrasonic Flaw Detector,</p> <p>Specification:  Equipments suitable for Training Purposes.</p>	Each one unit
17.	Metal Chemical Composition Analyzers.	Each one unit

# **SYLLABUS**

**FOR THE TRADE OF**

**FORGER & HEAT TREATER**  
**Engineering Technology**

**UNDER**

*CRAFT INSTRUCTOR'S TRAINING SCHEME*

**DESIGNED BY**  
**GOVERNMENT OF INDIA**  
**MINISTRY OF LABOUR(DGE&T)**  
**CENTRAL TRAINING INSTITUTE**  
**#10,ALANDUR ROAD**  
**GUINDY CHENNAI -600032**

# **GENERAL INFORMATION**

**1.NAME OF THE TRADE: FORGER & HEAT TREATER**

**2. DURATION: ONE YEAR**

**Module I- Trade Technology,**

**Module II-Trade Technology,**

**Module III-Engineering Technology,**

**Module IV-Training Methodology.**

**3. ENTRY QUALIFICATION: NTC With 2 year**

**Industrial experience**

**NAC With 1 year Industrial experience**

**in FORGER & HEAT TRATER trade**

**Or.**

**1 year Industrial experience**

**Or**

**Passed Degree in mechanical or, other relevant**

**field**

**WORKSHOP SPACE:**

**102Sq.mtr.**

**MEMBERS OF THE TRADE COMMITTEE  
FOR THE TRADE OF  
FORGER AND HEAT TREATER**

**MEMBERS**

1. Shri.D. VIJAYAKUMAR.  
JD / Principal, Chairman. CTII, Guindy,  
Chennai.600 032.
2. Shri.MS Balakrishnan.  
DD / Vice-Principal CTII, Guindy,  
Chennai.600 032.
3. Shri.SC Deogam,  
Assistant Director of Training. CTII, Guindy,  
Chennai – 600 032.
4. Shri.M. Kumaravel,  
Assistant Director of Training. ATI, Guindy,  
Chennai.600 032.
5. Shri.KV Ramakrishnan  
Training Officer CTII, Guindy,  
Chennai. 600 032.
6. Shri.S. Chockalingam  
Vocational Instructor (FM) CTII, Guindy,  
Chennai. 600 032.
7. Shri.T.L.Ravikumar.  
Vocational Instructor,  
(PATTERN MAKER / CARPENTER ) CTII, Guindy,  
Chennai.600 032.
8. Shri. M.sunthramurthy,  
Vocational Instructor. Drawing. CTII. Guindy,  
Chennai.600 032.
9. Shri. S.Jawhar.  
Vocational Instructor. Arithmetic CTII.Guindy,  
Chennai.600 032.
10. Shri.R. Vasudevan  
Rtd.Training Officer. RDAT,Guindy.  
Chennai
11. Shri. P.A. Jayaraman.  
Dy.general Manager. India Piston Ring Blank Unit.  
Marai malai nager, kanchipuram.
12. Shri.B. Ramprakash  
Vice Chairman ISNT, Chennai Chapter  
Guindy, Chennai.
13. Shri.T.N. Ramaswamy  
Foundry Technical Consultant Sr. Executive Engineer (Rtd.) M/s.  
Addition & Co. Ltd., Chennai.

14. Shri.PS.Viswanathan,  
Training Manager (Rtd.) M/s. Ashok Leyland,  
Chennai.
15. Shri.Dr. N.Rangaswamy, Ph.D.,  
Director Institute of Knowledge Potential  
Management, Chennai.
16. Shri.K.Srinivasan,  
Welding Consultant Aarthi Engineering & Consultant,  
Chennai.
17. Shri.S. Palanivelu,  
Dy.Manager Technical & Corporate. Metro pollution Transports  
Corporation, Chennai.
18. Shri.T.Ganesan  
Rtd. Section Manager (Foundry) Binny Engineering Pvt. Ltd.,  
Chennai
19. Shri.R.Veeraraghavan  
Sr. Manager, Metallurgical Addison & Co Pvt. Ltd., Chennai
20. Shri.P.Solomon  
Asst. Training Officer, F.H.T/ Fitter Govt. ITI (N), Chennai.
21. Shri.K. Manisekar  
Asst. Prof. HOD,  
Mechanical Department Vel Tech high tech Dr. Rangarajan  
Dr.Sagunthala Engg.College.  
Avadi, Chennai.
22. Shri.E. Baskaran,  
Workshop Instructor Murugappa Poly Technique Avadi,  
Chennai
23. Shri.R. Raguraj  
Asst. Training Officer (FM) Govt. ITI, Madurai
24. Shri.K. Thiruvencatam  
Asst. Trg. Officer (PM) Govt. ITI (N), Chennai.
25. Shri.S. Baskaran  
Junction Training Officer (FM) Govt. ITI (N), Chennai.
26. Shri.Thirumalai Kumar  
Jn. Training Officer Govt. ITI, Dharapuram.
27. Shri.S. Baskaran.  
Skilled Aritician(Foundry) AKMT Polytechnic,  
Chennai.
28. Shri.P.Solomon  
Asst. Training Officer, F.H.T/ Fitter Govt. ITI (N), Chennai.

## Draft Syllabus for ENGINEERING TECHNOLOGY MODULE ( C.I.T.S)

**TRADE: FORGER AND HEAT TREATER ,**

**Duration: 3 Months. ( 12 Weeks )**

Week No.	Work Shop Science And calculation.	Engineering Drawing	Remarks
1	<p>Importance of science and calculation to the Trade skill. Engineering materials Classification, Physical and mechanical properties of metal. Properties and uses of ferrous metals (pig iron, cast Iron, wrought iron Steel). Engineering materials and properties and uses of ferrous metals {plain carbon steel and alloys steels). Engineering materials-Properties and uses of non-ferrous metals {all alloys,copper,tin, lead and zinc} Properties and uses of metal alloys {Brass, Bronzes, Bearing metal,Solder,White metal}</p>	<p>Importance of Engineering Drawing and its knowledge. Use of drawing instrument,Tsquare,Drawing Broad etc. Letters, Number and alphabets as per IS 696/1972. Freehand sketching of straight lines, recyangles, circles, polygons etc. Use of different types of lines and symbols for drawing. Use of different types of lines and symbols for drawing Importance of putting dimension on the drawing as per IS 696/1972.freehand sketching with dimension, scale and proportionate sketching.</p>	
2	<p>Definition of Speed, velocity,and acceleration. Their units in different system-Difference between speed and velocity, equation of motion. Motion under the force of gravity-Simple problems.</p>	<p>Reading of simple blue print. Isometric views and oblique views with dimensions of such as cube, Rectangular-Block, Cylinder etc. Explanation of simple orthographic projection 1<sup>st</sup> angle&amp;3<sup>rd</sup> angle as per Ais696/1972.Sketching the views solid bodies when viewed perpendicular to their surfaces and axes.</p>	
3	<p>The square roots-The square and square root of whole number and decimal -Shop problems Decimal and percentages, Ratio and proportion.</p>	<p>Freehand sketching of plan and elevation of simple objects like hexagonal bar square bar, circular bar, tapered bar and hollow bar etc. Reading of simple blue print. Views of simple hollow and solid bodies with dimensions. Construct an orthographic projection from the given isometric view of shaped blocks in1st angle&amp; 3<sup>rd</sup> angle method. Exercise on blue print reading related to missing lines and missing views. Simple isometric</p>	

		<p>drawing –from the given orthographic views of simple objects.</p> <p>Forging symbols as per BIS employed on drawings. Freehand sketching of rivets &amp; washers with dimensions from samples as per BIS .</p> <p>Freehand sketching of riveted joints. Key and cotters &amp; Screw threads with their dimensions from samples as per BIS .</p>	
4	<p>Algebra- simultaneous and quadratic equations and problems. Trigonometry – Definition, trigonometrically formulaic, simple problems like finding the value, proof etc.</p>	<p>Exercise on blue print reading relating identification of surface symbols.</p> <p>Triangular prism and hexagonal prism- projection and development. Cylinder projection and development, cone projection and development. Examples based on right cones.</p>	
5	<p>Definition of mass and weight ,their units, difference between mass and weigh, specific gravity, difference between density and specific gravity,Archimedesprinciple,finding out of specific gravity.</p>	<p>Views of of simple solid &amp; simple hollow bodies cut by section plane on drawing standard method (full &amp; half section )IS696/1972. Exercises on blue print reading.</p>	
6	<p>Mensuration : area square, rectangle, equilateral triangle , isosceles triangle, right-angled triangle, scalene triangle- problems. Pythagoras’s theorem- shop problems.</p>	<p>Sketching of finished articles from drawing and preparation of sequence of operations. Conventional representation materials by BIS. Method of indicating surface roughness by BIS</p>	
7	<p>Heat and Temperature,-effect of heat, unit of heat-calorie,BTh U, C H U –specific heat, latent heat ,thermal capacity –Transmission of heat (conduction, convection, radiation) Heat and temperature scale such as Celsius, farahrenheit and Kelvin, temperature measuring instrument, conversion between the above scales of temperature-Difference between heat and temperature</p>	<p>freehand sketching with dimension, scale and proportionate sketching. Freehand sketching of nuts and bolts with dimensions from samples.</p>	
8	<p>Lever –Type of lever with their examples. Simple problems on straight and bell cranked Stress and strain –different type of stresses, hooker’s law, Jung’s modules, yield point, ultimate stress and working stress, factor of safety – simple problems. Simple machines –Effort and load, mechanical advantage and velocity ratio, output and input ,Efficiency of machine and simple problems.</p>	<p>Exercise on reading of drawing, related to missing line and missing views.</p> <p>Simple isometric drawing from the given, Orthographic view of simple objects.</p>	

9	Friction – Definition, advantages and disadvantages, normal reaction, limiting friction, laws of limiting friction coefficient of friction- simple problems	Trade related BIS symbols. Free hand sketches of hand tools, trade related drawing.  Freehand sketching of nuts and bolts with dimensions from samples.	
10	Inspection and Tests for Quality Control, Non destructive Testing(NDT) Radiographic Testing of heat treated materials and forged components .	Geometrical Development of Prism, Pyramid and Isometrics. Triangular prism, and hexagonal Prism –projection development	
11	Materials- Specification related to trade. Costing of forged components	Conventional representation of material by BIS. Free hand sketching of simple objects related to the trade and preparation of simple working drawing from the sketches. View of simple solid bodies cut by section plane on drawing standard methods Cylinder projection and development, cone projection and development Examples based on right cones	
12	Revision & Test	Revision & Test	

**ENGINEERING TECHNOLOGY**

**ENGG. DRG/ WSC- THEORY CLASS –EQUIPMENTS / TOOLS / ACCESSORIES**

1. Junior drafting machine - Each1
2. Set of set square (45°, 30°/60°) (celluloid material) - Each1
3. Circular template (celluloid material) - Each1
4. Protractor (celluloid material) - Each1
5. Square and rectangle template (celluloid material) - 1 by 2
6. Set of French curves (celluloid material) - 1 by 2
7. Compass & divider Box (celluloid material) - Each1
8. Scales
  - a. Full scale (Wood or celluloid) -Each 1set
  - b. Enlarged scale (Wood or celluloid) -Each1set
  - c. Reduced scale (Wood or celluloid) -Each 1set
9. Geometrical Box set- class work (celluloid or wood) -Each 1set
10. Glass Board 8' × 4' - 1No
11. White Board 8' × 4' - 1No
12. Interactive Board with accessories - 1No
13. Computer with Auto-CAD software - 1No

# ENGINEERING TECHNOLOGY

## SCIENCE LAB-EQUIPMENTS & ACCESSORIES

### 1. Different metal models

- Ferrous metal -1 set
- Non ferrous metal -1 set
- Alloys -1 set

### 2. Density

- Volume and Weight calculation of solid models  
(Cube, Cuboids, cylinder, cone, sphere etc.)
- Vernier Caliper -1no
- Micrometer -1no
- Physical balance with weight box -1set
- ELECTRONIC BALANCE -5kg (max) -1unit
- Spring balance (0.1 to 1kg) -2sets
- Lactometer -1no
- Hydrometer -1no
- Beakers 50cc, 100cc, 200cc -3nos each
- Cylindrical glass jar -4nos
- Graduated cylindrical jar(100cc, 500cc) -2nos each

### 3. Magnet

- Rectangular solid bar -2nos
- U-type -1no

### 4. Pressure

- Barometer - 1no
- Manometer - 1no

### 5. Levers

- Cutting pliers, scissors, claw hammer - Each 1No
- Nut cracker, wheel barrow, Trolley - Each 1No
- Coal tongs, safety valve - Each 1No
- Cycle Bell - 1No

6. Simple Machine
- Pulley block (Model) -1No
  - Wheel and axle (Model) -1No
  - Wheel and differential axle (Model) -1No
  - Screw Jack (Model) -1No
  - Pulleys
    - Fixed pulleys -1Set
    - Movable pulleys -1Set
7. Work power & energy
- Work calculation – model -1No
  - Energy conversion – model -1No
  - Power calculation - model -1No
8. Friction
- Inclined plane- model -1No
  - Application of friction – model -1No
9. Heat
- Heat transformation equipments (Different metal rods) -1Set
  - Scales of temperature - model -1set
  - Thermometers ( $^{\circ}\text{C}$ ,  $^{\circ}\text{F}$ ,  $^{\circ}\text{R}$ ) -2Each
  - Calorimeter -1no
  - Thermos flask -1no
  - Pyrometer
    - Thermocouple -1no
    - Optical -1no