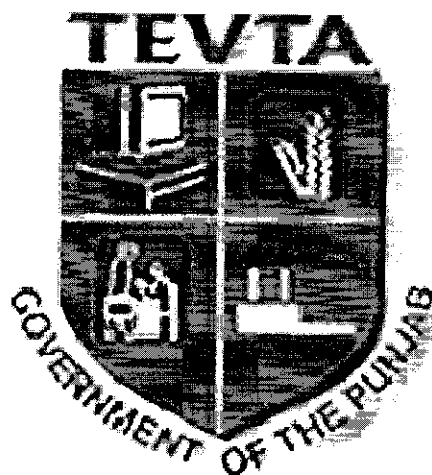


GOVERNMENT OF THE PUNJAB

TECHNICAL EDUCATION & VOCATIONAL TRAINING AUTHORITY



CURRICULUM FOR

**Material Evaluation and Mechanical Testing  
(3 – Months Course)**

Evaluated, December 2015

CURRICULUM SECTION  
ACADEMICS DEPARTMENT

96-H, GULBERG-II, LAHORE

Ph # 042-99263055-9, 99263064

[gm.acad@tevta.gop.pk](mailto:gm.acad@tevta.gop.pk), [manager.cur@tevta.gop.pk](mailto:manager.cur@tevta.gop.pk)

3-12-15

**TRAINING OBJECTIVES:**

- To Train about the basic concept of material evaluation and mechanical testing of metals and alloys.
- To Train about knowledge and skills by using state of the art technology in respect of metals and alloys, manufacturing techniques & quality control.
- To Train about the need based skilled manpower, equipped with latest techniques and advanced technical know-how in Material evaluation and mechanical testing.
- To Train and fulfill the vacuum that already exists in this specialized field of study.

**CURRICULUM SALIENT:**

Name of the Course	:	“Material Evaluation and Mechanical testing”
Entry level	:	Matric and above.
Duration of course	:	3-Months.
Total training hours	:	400 hours.
Training hours per week	:	40 hours
	:	7 Hours per day except
	:	5 Hours Friday
Training Methodology	:	Practical 90 %
		Theory 10 %

**SKILL COMPETENCY DETAILS: -**

On the successful completion of this course the trainees should be able to:

- Use the capability & capacity to perform chemical analysis of seven (07) main elements in Steel & stainless steel.
- Apply the basic concept of material evaluation and mechanical testing of metals and alloys (Ferrous & Non-ferrous).
- Construct the competency to run & execute emission spectrometer, spectrophotometer, carbon sulphur determinator, UTM, Impact Tester, Hardness Tester etc
- Apply the basic knowledge of Non Destructive Testing ( NDT) etc

**KNOWLEDGE PROFICIENCY DETAILS: -**

On the successful completion of this course the trainees should be able to:

- Define standards for measuring the material quality.
- Describe standards for implementation of quality testing methods & practices at organization level.
- Identify the critical aspects needed for success in the job and organization. etc

**CURRICULUM DELIVERY STRUCTURE**

Area	Curriculum Delivery	Make up Session	Revision	Final Test	Total
W E E K	1 – 10	11	12	13	13
	10	1	1	1	13

**SCHEME OF STUDIES****Material Evaluation and Mechanical Testing  
(3 – Months Course)**

<b>Sr. No</b>	<b>Main Topics</b>	<b>Theory Hours</b>	<b>Practical Hours</b>	<b>Total Hours</b>
1.	Emission Spectrometer	05	80	85
2.	Carbon Sulphur Determinator	05	50	55
3.	Metallography	05	50	55
4.	Spectrophotometer	04	50	54
5.	Wet Analysis	04	50	54
6.	Mechanical Testing	05	80	85
8.	Work Ethics	12	0	12
<b>Total</b>		<b>40</b>	<b>360</b>	<b>400</b>

Developed by Curriculum Section, Academics Department TEVTA.

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**DETAIL OF COURSE CONTENTS**

(3– Months Course)

Sr.No	Detail of Topics	Theory Hours	Practical Hours
1.	<b>Emission spectrometer</b> 1.1 Working Principle 1.2 Preparation of sample 1.3 How to start spectrometer 1.4 How to start software 1.5 How to turn off the spectrometer 1.6 Main Parts of the equipment 1.7 Specifications of Argon Gas 1.8 Purpose of Argon purifier 1.9 How to clear the electrode 1.10 Dimensions of samples used 1.11 Indication of correct spark 1.12 Water purification 1.13 Display options 1.14 Troubleshooting 1.15 Repair & Maintenance 1.16 Practical	05	80
2.	<b>Carbon Sulphur Determinator</b> 2.1 Working principle 2.2 How to determine/calculate carbon-sulphur contents 2.3 Practical's	05	50
3.	<b>Metallography</b> 3.1 Cutting 3.2 Mounting 3.3 Grinding 3.4 Polishing 3.5 Etching 3.6 Microscopy 3.7 Structural analysis 3.8 Practical's	05	50

4.	<p><b>Spectrophotometer</b></p> <p><b>4.1 Analytical Techniques</b></p> <p>4.1.1 Introduction</p> <p>4.1.2 Spectrometry</p> <p>4.1.3 Principal</p> <p>4.1.4 Spectroscopy Spectrophotometer</p> <p>4.1.5 Practical's</p> <p><b>4.2 Instrument of Measurement</b></p> <p>4.2.1 Absorption of light</p> <p>4.2.2 Graphical Relation</p> <p>4.2.3 Beer's Law</p> <p>4.2.4 Light Source</p> <p>4.2.5 Monochromatic</p> <p>4.2.6 Absorption cell</p> <p>4.2.7 Detector</p> <p>4.2.8 Practical</p> <p><b>4.3 Wavelength Cell Time Program</b></p> <p>4.3.1 Wavelength program</p> <p>4.3.2 Single wavelength program</p> <p>4.3.3 Cell program</p> <p>4.3.4 Time program</p> <p>4.3.5 Wavelength and cell program</p> <p>4.3.6 Wavelength and time program</p> <p>4.3.7 Multi program</p> <p>4.3.8 Formula program</p> <p>4.3.9 Program example</p> <p>4.3.10 Practical</p> <p><b>4.4 Quantitative Analysis</b></p> <p>4.4.1 Ratio wavelength</p> <p>4.4.2 Multiwave length assays at 2 or 3 wavelength</p> <p>4.4.3 Band area and height correction</p> <p>4.4.4 Practical's</p> <p><b>4.5 Operation Using Stored Methods</b></p> <p>4.5.1 Introduction</p> <p>4.5.2 Stored method</p> <p>4.5.3 List method</p>	04	50
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	4.5.4 Recall method 4.5.5 Delete method 4.5.6 Store current state 4.5.7 Practical <b>4.6 Validation</b> 4.6.1 Introduction 4.6.2 Wavelength validation 4.6.3 Adsorption validation 4.6.4 Resolution validation 4.6.5 Practical		
5.	<b>5.1 Wet Analysis</b> 5.1.1 Introduction 5.1.2 Gravimetric Analysis 5.1.3 Volumetric Analysis 5.1.4 Role in industry 5.1.5 Practical <b>5.2 Wet Analysis for different Metals</b> 5.2.1 Chromium 5.2.2 Nickel 5.2.3 Magnesium 5.2.4 Manganese 5.2.5 Molybdenum 5.2.6 Others 5.2.7 Practical	04	50
6.	<b>6.1 Mechanical Testing</b> 6.1.1 Destructive testing 6.1.2 Nondestructive testing <b>6.2 Universal Tensile Testing Machine</b> 6.2.1 Tensile test. 6.2.2 Properties related with test. 6.2.3 Specimen specifications. 6.2.4 Construction. 6.2.5 Operating procedure 6.2.6 Stress strain curve 6.2.7 Troubleshooting 6.2.8 Repair & Maintenance 6.2.9 Practical <b>6.3 Impact Test</b> 6.3.1 Significance of impact test 6.3.2 Charpy test 6.3.3 Specimen specification	05	80

	6.3.4 Effect of important variables on impact strength 6.3.5 Maintenance and repairing 6.3.6 Practical <b>6.4 Hardness Testing ( Rockwell &amp; Brinell )</b> 6.4.1 Introduction 6.4.2 Brinell hardness tester 6.4.3 Precautions 6.4.4 Advantages 6.4.5 Limitations/Disadvantages 6.4.6 Rockwell hardness test 6.4.7 Precautions 6.4.8 Advantages 6.4.9 Disadvantages/limitations 6.4.10 Practical's <b>6.5 Non Destructive testing (optional)</b> 6.5.1 Introduction 6.5.2 Radiography 6.5.3 Magnetic particle inspection 6.5.4 Ultrasonic inspection 6.5.5 Eddy current inspection		
8.	<b>Work Ethics</b>	12	
<b>Total</b>		<b>40</b>	<b>360</b>

**LIST OF PRACTICAL:****1. Emission spectrometer**

- 1.1 Preparation of sample
- 1.2 How to start spectrometer
- 1.3 How to start software
- 1.4 How to set parameters
- 1.5 Standardization of machine
- 1.6 Analysis of different ferrous metals
- 1.7 Analysis of non-ferrous metals
- 1.8 How to turn off the spectrometer
- 1.9 How to Troubleshoot and repair & maintenance of machine
- 1.10 How to prepare technical report

**2. Carbon Sulphur Determinator**

- 2.1 Preparation of sample
- 2.2 How to start Carbon Sulphur Determinator
- 2.3 How to start software
- 2.4 How to set parameters
- 2.5 Standardization of machine
- 2.6 Analysis of different metals
- 2.7 How to turn off the Carbon Sulphur Determinator
- 2.8 How to Troubleshoot and repair & maintenance of machine
- 2.9 How to prepare technical report

**3. Metallography**

- 3.1 Cutting technique of sample
- 3.2 Mounting procedure
- 3.3 Grinding techniques

- 3.4 Polishing techniques
- 3.5 Etching procedure
- 3.6 How to use Metallurgical Microscope
- 3.7 Structural analysis of ferrous and non ferrous metals
- 3.8 How to prepare technical report

#### **4. Spectrophotometer**

- 4.1 Analytical Techniques
- 4.2 How to set Wavelength Cell Time Program
- 4.3 How to perform Quantitative Analysis
- 4.4 Validation process

#### **5. Wet Analysis**

Analysis techniques/procedure of following elements

- 5.1 Chromium
- 5.2 Nickel
- 5.3 Magnesium
- 5.4 Manganese
- 5.5 Molybdenum
- 5.6 Others

#### **6. Mechanical Testing**

##### **6.1 Universal Tensile Testing Machine**

- 6.1.1 Preparation of sample
- 6.1.2 How to start machine
- 6.1.3 How to start software
- 6.1.4 How to set parameters
- 6.1.5 Analysis of different steel bars
- 6.1.6 Analysis of concrete blocks
- 6.1.7 How to turn off the machine

6.1.8 How to Troubleshoot and repair & maintenance of machine

6.1.9 How to prepare technical report

## **6.2 Impact Test**

6.2.1 Preparation of sample

6.2.2 How to start machine

6.2.3 How to set parameters

6.2.4 Analysis of different metal samples

6.2.5 How to turn off the machine

6.2.6 How to Troubleshoot and repair & maintenance of machine

6.2.7 How to prepare technical report

## **6.3 Hardness Testing (Rockwell & Brinell)**

6.3.1 Preparation of sample

6.3.2 How to start machine

6.3.3 How to set parameters

6.3.4 Hardness testing of different ferrous and non ferrous metallic samples

6.3.5 How to turn off the machine

6.3.6 How to Troubleshoot and repair & maintenance of machine

6.3.7 How to prepare technical report.

## **6.4 Radiography (optional)**

6.4.1 Radiography of stainless steel castings.

6.4.2 Radiography of brass castings.

## **6.5 Ultrasonic Inspection**

6.5.1 Determine the internal flaws by Ultrasonic Inspection

## **6.6 Magnetic Particle Inspection**

6.6.1 Determine the surface cracks, by Magnetic particle Inspection

## **6.7 Eddy Current**

6.7.1 Determine the irregularities in structure of electrically conductive materials by eddy current inspection

**LIST OF LABS:**

Following labs are Utilized/Engaged during this course:

- Testing and certification Lab.
- Mechanical testing Lab.
- Wet analysis Lab.
- NDT Lab (Optional)

**LIST OF TOOLS AND EQUIPMENT**

(For class of 25 students)

<b>Name of Trade</b>	<b>A practical course on “Material Evaluation and Mechanical Testing”</b>
<b>Duration of Course</b>	<b>3 Months</b>

<b>Sr.No</b>	<b>Tools/Equipment</b>	<b>Quantity</b>
1.	Emission Spectrometer	01
2.	Carbon Sulphur determinator	01
3.	Mounting press	01
4.	Grinders (rough and fine)	01
5.	Polishing Machine (Polisher)	01
6.	Metallurgical Microscope	01
7.	Universal Testing Machine (UTM)	01
8.	Brinell Hardness Tester	01
9.	Rockwell Hardness Tester	01
10.	Impact Testing Machine	01
11.	Spectrophotometer	01
12.	X-Ray Machine (Optional)	01
13.	Ultrasonic apparatus (Optional)	01
14.	Eddy current tester(Optional)	01
15.	Ferrous & Non-Ferrous Metals	As per requirements

**LIST OF CONSUMABLE MATERIAL**

(For class of 25 students)

Sr.	Material	Quantity
1.	Argon Gas	02 cylinder
2.	Phenolic Resins	1Kg
3.	Emery Papers of different grit sizes	10 Nos each size
4.	Diamond Past	2 Nos.
5.	Etchants <ul style="list-style-type: none"> <li>• Picric Acid</li> <li>• Nital</li> <li>• Ferric Chloride</li> <li>• Ammonium per sulphate</li> <li>• Hydrofluoric Acid</li> </ul>	50ml 50ml 50ml 50ml 50ml
6.	Standard samples	28Nos.
7.	Sodium arsenate	100ml
8.	Ferrous Ammonium sulphate	500ml
9.	Ammonium per Sulphate	750ml
10.	Sulphoric Acid ( $H_2SO_4$ )	300ml
11.	Nitric Acid ( $HNO_3$ )	300ml
12.	Silver Nitrate ( $AgNO_3$ )	300ml
13.	Sodium Chloride ( $NaCl$ )	300ml
14.	Indicators ( N-phenol, Anthracic acid)	300ml
15.	Iron powder	200g
16.	Penetrant	4 bottles
17.	Developer	4 bottles



**MINIMUM QUALIFICATION OF INSTRUCTOR**

1. B.Sc. Engineering in Metallurgy and Material Sciences/Mechanical.

OR

2. B.Tech in Mechanical Technology with hands on experience.

OR

3. DAE in Mechanical/ Cast Metals and Foundry Technology with three (03) years' experience.

**REFERENCE BOOKS**

1. “Physical Metallurgy” by Avnar.
2. “Mechanical Metallurgy” by Diter.
3. “Principals of Material Sciences” by William Smith.
4. The “Testing & Inspection of Engineering Materials” by Davis, Troxell & Wiskocil
5. ASM Handbook of “Mechanical Testing and Evaluation” Vol 8.
6. ASM “Metallographer’s Guide”.
7. “Engineering Physical Metallurgy” by Lakhin.
8. “Engineering Physical Metallurgy” Nicholas Weinstein.
9. “Chemical Analysis for Iron Foundries” by Bcira.
10. “Testing of Material by Dr. Fazal Kareem.
11. “Microstructure Development during Metal Casting” by Jhon E. Gruzleski.
12. ASM” Metallography & Microstructures” Vol 9. etc

**EMPLOYABILITY OF PASS-OUTS**

The pass outs of this course may find job / employment opportunities in the following areas / sectors: -

- Automobile Industry
- Agriculture Industry
- Cast Metals & Foundry Industry
- Cement/Sugar Plant Making Industry
- Textile Industry
- Surgical Instrument Industry
- Oil & Gas sector
- Petrochemical Industry
- Defense Industry

**CURRICULUM EVALUATION COMMITTEE**

**Mr. M. Tariq Mehmood khan**

Sr. Instructor Mechanical

GCT Railway Road Lahore.

(Convener)

**Mr. Atif Attique**

Instructor Mechanical

GCT Railway Road Lahore

(Member)