

**MOTOR WINDING
COURSE CONTENTS - 10TH CLASS**

THEORY

Text	Scope
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Chapter No. 1

**1. Types of 3-Phase motor
(04 periods)**

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|-----------------------------------|---|
| 1.1 Squirrel cage induction motor | <ul style="list-style-type: none">• Explain the construction and working of squirrel cage induction motor |
| 1.2 Wound rotor motor | <ul style="list-style-type: none">• Explain construction, working and starting methods |

Chapter No. 2

2. Winding procedure of Single Phase Motors (08 periods)

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| 2.1 Winding of single phase induction motor (capacitor type & non-capacitor type) | <ul style="list-style-type: none">• Describing the construction, working principle, formation of coil and finding coil pitch• Describing starting winding & running• Describing sleeveing, soldering & connection as per drawn diagrams• Varnishing, drawing and assembling of the motor• Describing fault finding in single phase motor |
| 2.2 Rewinding of three phase induction motor | <ul style="list-style-type: none">• Describing a three phase motor working principle, rotating field of a three phase motor and its direction• Describing connection circuit diagram• Describing how to remove burnt coil• Finding number of turns• Number of coils per phase |

Text	Scope
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- Preparing insulation for slots
- How to place coils
- Making final connection
- Describing sleeveing, soldering, taping & varnishing
- Demonstrate assembling & testing

Chapter No. 3

**3. Motor Protection/Testing
(06 periods)**

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| 3.1 | Over current protection | <ul style="list-style-type: none"> • Describe purpose of over current protection • Method of over current protection • Describing how an over current relay is connected |
| 3.2 | Motor Starters | <ul style="list-style-type: none"> • Describe the kinds of starters • Describe how starters are connected in the circuit • Describe low voltage and over voltage protection of motor |
| 3.3 | Magnetic contactors, relays, circuit breakers & time delay relays | <ul style="list-style-type: none"> • Explain the construction, working of magnetic contactors, relays, circuit breakers & time relays |
| 3.4 | Testing of motors | <ul style="list-style-type: none"> • Describe continuity test • Insulation resistance test • Describe load test |

Chapter No. 4

**4. Generator/Alternators (Small)
(04 periods)**

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| 4.1 | Generator & its working principle | <ul style="list-style-type: none"> • Describe the working principle of a generator • Describe the parts of a generator |
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Text	Scope
4.2 Fault finding in a D.C. generator	<ul style="list-style-type: none"> • Describing open circuit test, short circuit test
4.3 A.V. regulator	<ul style="list-style-type: none"> • Describing an A.V. regulator its working & connection
4.4 Rectification	<ul style="list-style-type: none"> • Describing rectification by diode, transistor

MOTOR WINDING

LIST OF PRACTICALS -10TH CLASS

1. Removing of old winding, noting the gauge of wire used in primary and secondary winding, number of turns of both winding/looping.
 - Preparation of bobbin, and former (Pattern).
 - Placing of insulation paper on the bobbin and in the layers of winding.
 - Rewinding of both winding.
 - Final connection and soldering to lips of terminals
 - Testing, Varnishing and baking.
 - Final testing.
 - Battery charger (Rectification).

2. D.C. Winding

- 2.1 Identifying and using parts of DC motor.
 - Identifying and using the different type of connection, series, shunt and compound.
 - Systematic detection of faults.
 - Dismantling of D.C. motor.
 - Identifying the connection of field coils.
 - Removing of burnt coil of winding.
 - Identifying the gauge of wire, number of turns of field coils.
 - Identifying the gauge of armature winding and number of turns coil, number of loops coil, coil pitch and type of connection of winding.
 - Removing old/burnt winding of armature.
 - Checking and testing of commutator, segment insulation.
 - Identifying and using of the class of insulation paper used in armature slots.
 - Clearing the slots of armature, preparing and placing of insulation in the slots.
 - Identifying and using of winding wires.
 - Identifying and using of sleaveing.
 - Preparing of winding diagram.
 - Removing of field coils and their final connections after removing enamel and soldering.
 - Removing of armature and its connection after removing enamel and sleaveing of connection.
 - Soldering of connection on commutator.
 - Final testing of armature (Growler test).
 - Drying, re-varnishing and baking.
 - Reassembling of D.C. motor and testing on line.

3. Servicing of Electric Motor
 - General routine check and maintenance of electrical machines and appliances.
 - Finding of faults.

- Dismantling, repair reassembling, setting of motors and auxiliary equipments.
- Over hauling of machines.
- Replacement of worn out parts.
- Reassembling of motor and appliances.
- Testing of motors and appliances on line measuring current and voltage drop.
- Checking the sound of motor and replacement of bearing if defective.

4. Motor Protection

- Circuit breakers, earthing and testing of its resistance.
- Magnetic, contactors, over load relay and timers.
- Starters for A.C. motor, star delta starter, automatic and manual

MOTOR WINDING
LIST OF EQUIPMENT, TOOLS AND CONSUMABLE MATERIALS

EQUIPMENT

1. Manual coil winding machine with 5 each counter
2. Electric coil winding machine with variable speed
3. Coil formers of different sizes
4. Growlers, Tong tester
5. Digital and analogue multi meter
6. Used/burnt fans
7. Motors
8. Fan regulators
9. D.C. small motor
10. Portable alternator (2KVA)
11. Batteries
12. Battery charger
13. Transformer (used) for winding practice

LIST OF TOOLS AND INSTRUMENTS

1. Checking and Measuring Tools
 - Steel rules of different sizes.
 - Steel measuring tapes – 6, 10 feet
 - Vernier Caliper – 12
 - Micro meters - 0 – 25 mm
 - Out side and inside calipers 6
2. Cutting Tools
 - Cold cheisels 8 x 1
 - Hand backsaw from hand wood saw tin cutter/snip,
 - Electrician's knife, Wire stripers
 - Wire cutter, Cable cutter of different type and sizes

3. Pliers
 - Compilation pliers, Flat nose pliers, Round nose, Circle pier external and internal thimble pliers (Grip) pliers
4. Files
 - Files of different type and size
5. Hammers
 - Hammers of different type and size
6. Mallets – Rubber & Wooden
7. Vices
 - Bench vices, Machine vices and Hand vices of different type and sizes
8. Punch set
 - Centre punches
9. Marking Tool
 - Line scribe, marking block and dividers of different types
10. Allen Keys
 - Allen keys set
11. Spanners/Wrenches
 - Open-ended spanners, Ring spanners, Reversible racket wrenches and adjustable wrenches of different type and size
12. Screw Drivers
 - Flat edged blade screwdrivers
 - Philips type screwdrivers of different type and size
13. Drill Machines
 - Hand ball machine, Counter sink drill, Stone drills – H.S.S. Drill Bits, Size selection of Drill
14. Soldering Irons
 - Non Electric Soldering irons
 - Electric Soldering irons
 - Electric sucker, blowlamps
15. Grinders
 - Pedestal Grinders Single Phase
 - Hand grinders, Motorized Grinders

16. Grease Guns
 - Oil Cans
17. Bearing and Pulley Puller
 - Bearing Pullers
18. Cleaning and Scraping Tools
 - Flat scraper, Wire burses
 - Simple Blower Pump, Electric blower
19. Tweezers
20. Speed Measuring Devices
 - Speedometers of various types
 - Speedometer digital type
21. Wire Gauges and other Gauges
 - S.W.G. wire and sheet gauge
 - A.W.G wire gauges
 - Feeler Gauges
22. Electrical Testing Devices
 - Electric test lamps
 - Phase tests, Growler, Megger
23. Drying and Baking Devices
 - Dryers, Electric oven
24. Circuit Breakers, Magnetic contactors, Over Load Relay, Timers, Earth Leakage Breaker
25. Measuring Devices
 - Ohm meter (A.V.O) meter, Megger, Volt meter, AC/DC
 - Ampere meter, 1 Phase – Energy (K.W.H) meter (Single Phase 3-Phase) Frequency meter

MOTOR WINDING

CONSUMABLE MATERIALS

ITEMS	QUANTITY
1. Winding Enamel wire – size 18 to 36 S.W.G	10 kg each Nos.
2. Leathroid paper No 7&10	20 kg
3. Insulating/ Varnish	20 lit
4. Sleeves (1mm to 10 mm)	100 each Nos.
5. Cotton tape $\frac{3}{4}$	100 Rolls
6. Cotton Thread	50 Rolls
7. Soldering Wire 40/60	50 Rolls $\frac{1}{2}$ kg
8. Soldering Paste	1 kg
9. Electric wire single core 3/029	10 coils
10. Electric wire single core 7/029	5 coils
11. Electric wire 3 core 7/064	2 coils
12. Electric wire 4 core 7/.064	1 coil
13. Flexible wire 3 core 23/0076	2 coils
14. Flexible wire 4 core 40/.076	2 coils
15. Electric accessories such as switches, socket, holders, circuit breaker single-phase – 3 phase	20 Nos. each

MOTOR WINDING REFERENCE BOOKS FOR TEACHERS

- Tables for electric trade TTP (Development Cell for Skilled Labour Training, Lahore (GTZ))
- GTZ Electrical Power Engineering Proficiency Course
- A Textbook of Electrical Technology by B.L. Theraja.
- Electrical Installation and regulation by Michael Neidle 3rd Edition
- Electrical Installation by A.O. Akintanti and J.M. Hyde

GENERAL RECOMMENDATIONS

Text Book

1. The textbook should be fully illustrated based on approved national curriculum.
2. The language used should be Urdu/English. Script should be simple and easy. Examples should be chosen from every day life wherever possible.
3. There should be uniformity in terminology in textbooks. For this purpose a glossary of uniform terminology based upon S.I. Units should be prepared and provided.
4. The Technical Terms/Terminology should not be translated as such and these should be directly written in Urdu.
5. Objective type as well as descriptive test items should be provided at the end of each chapter, which should serve as guideline for students and teachers.
6. The experiments suggested in the curriculum should be dealt with in detail in a separate Practicals' Manual. The experiments should be prescribed in an open-ended manner.
7. Since curriculum development is a continuous process, a follow-up committee should be formed to check its proper implementation and evaluation.

Practical Manual

In order to maintain a uniform standard of practical activities throughout the country, Practical Manual should be prepared for the purpose. This manual should cover all the practicals in the trade indicating Title of practical, material, Tools & Instruments, Procedure, figure(s), Readings/ output data/result/conclusions and safety precautions etc. The final practical examination should be based on the activities prescribed in the curriculum.

Teacher's Guide

In order to provide direction in the planning of academic activities, the Trade teacher needs some resource material to bank upon. A teacher's guide giving essential background information, knowledge, lesson schemes, objectives, teaching methodologies, motivation, conducting practical, assessment procedures etc. be prepared for the purpose and provided to the Trade teachers.

Workshop

1. In order to facilitate the students to develop desired skills and competencies, it is recommended that practical activities should be carried out individually, where possible.
2. The workshop should be fully equipped as stipulated in the Curriculum. Provision should be made in school budget to purchase/replace latest tools and equipments to update the workshop.
3. Recommended consumables should be provided for practicals in reasonable quantity.

Evaluation of Curriculum

It is recommended that provincial curriculum evaluation committees should be formulated on permanent basis comprising curriculum experts, teacher trainers, working technical teachers, experts, subject specialists and educationists to evaluate the shortcomings and achievements of the curriculum. The committees will be expected to remain in contact with the teachers to obtain feedback for decision making.

Methodology of Instruction

Following methods of teaching may be used in technical education as considered appropriate by the teacher:

1. Project Method
2. Illustration Method
3. Investigation Method
4. Demonstration Method
5. Practice/Drill Method
6. Lecture Method
7. Assignment Method
8. Discussion (Questions & Answers) Method
9. Visit to industry
10. Tutorial

Characteristics of Technical Teachers

For effective instruction, the desirable qualities of competent technical teachers should be:-

- a) Good manager, facilitator, and counsellor
- b) Educational background and industrial experience
- c) Mastery of instructional techniques
- d) Competence in the subject
- e) Resourcefulness and creativeness
- f) Ability to develop good personal relationship with students
- g) Knowledge of performance evaluation procedures

Promotional Activities

During education various co-curricula activities develop and promote interest, positive attitudes and commitment. Following activities may be utilized to promote Vocational and Technical Education:

1. Technical club
2. Bulletin Board
3. Exhibition corner

4. Display of Projects
5. Quiz Contests
6. Technical & Science exhibition
7. Technical & Science Fair
8. Technical & Science Olympiad etc.

Assessment of Student Achievement

The procedure in vogue for evaluation is the examination. It is however, suggested that in addition to annual examination, the teachers should also evaluate class work on completion of each lesson/unit followed by periodic tests in the subject. Besides periodic and annual tests, skill standards prepared by National Training Bureau should be used at the end of the year.

For the purpose of class-room appraisal, individual as well as group technique may be used. The tests should comprise both short answer and objective type questions. Assessment should focus knowledge, skills, competencies, and application of concepts and ability to use the techniques and tools. It is therefore, suggested that a comprehensive scheme of knowledge, skills, competencies etc. be prepared to assess students' achievements. Rigorous efforts are needed to prepare such items. Standardized test items, be prepared for the use of the examining Boards and also for the classroom teachers.

It is to be kept in mind that students study habits are influenced by the teacher's method of testing. It is therefore, suggest that examination should be a meaningful activity.

Recommended Scheme of Studies

Each vocational subject is being divided into two parts – theory and practical, of 50 marks each. Geometrical and Technical Drawing is included as an essential part of the engineering trades. Questions of 20 % marks will be from Geometrical and Technical Drawing and the rest of the examination will be of 80% marks covering the whole theory and practical course of the respective trade.

Relative Marks distribution in Examination is as under:

Theory Paper: 50	(i)	Trade	40 Marks
	(ii)	Geometrical & Technical Drawing	10 Marks
Practical Paper: 50	(i)	Trade	40 Marks
	(ii)	Geometrical & Technical Drawing	10 Marks
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Total:100			
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In the examination, the level of learning abilities to be tested may be taken as:

Knowledge – The ability to recall facts, nomenclature, classifications, practical techniques, laws and theories, straight-forward calculation and computation.

Comprehension – The ability to translate data from one form to another (verbal into mathematical, tabular or graphical and vice versa) to interpret or deduct the significance of data, and to solve problems.

Application – The ability to apply knowledge, experience and skill to new situations presented in a novel manner.

In the theory examination paper such questions may be set which facilitate to test learning abilities related to *Knowledge*, *Comprehension* and *Application*.

The questions asked may provide the students an opportunity to give reasoned arguments, to apply his knowledge to the theoretical and practical problems, or to interpret given data and apply in the situation described thereby.

In the practical examination, the student will be required to perform a practical, to use tools and equipment, to observe and tabulate data, perform calculations and draw graphs, to locate fault, to make physically required circuits, to troubleshoot and repair desired circuit/unit etc.

In the practical examination, the level of competencies and skill to be tested may be taken into five categories as:

Imitation - The ability to observe skill and attempt to repeat it.

Manipulation - The ability to perform skill according to instruction rather than observation.

Precision - The ability to reproduce a skill with accuracy, proportion, and exactness.

Articulation- The ability to combine more than one skill in sequence with harmony and consistency.

Naturalisation – The ability to comprehend one or more skills with ease and adapt automatically with limited physical or mental exertion.

Use of Tools - The skills and competencies to use tools and equipment.

Approximate percentage of marks allotted to each of the above abilities may be:-

<i>Knowledge</i>	20 %
<i>Comprehension</i>	25 %
<i>Application</i>	15 %
<i>Skills and competencies</i>	40 %