DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

POWER OPTION

MODULE II

MODULE II - ELECTRICAL POWER GENERATION AND TRANSMISSION

Introduction

This module is designed to enable the trainee acquire necessary knowledge, skills, attitudes and Competence that can be utilized in Electrical , Electronics and Instrumentation works, and in a general production line

The graduate of this module has the necessary skills for the world of work as a technician or be self employed in an Electrical, Electronics and Instrumentation workshop.

General Objectives

At the end of this module the trainee should be able to:

a) Understand the general concepts of electronic and instrumentation systems
b) Understand industrial measurements and control techniques
c) Appreciate maintenance of electronics and instrumentation systems
d) Know the use of ICT in understanding electronics and instrumentation technology
e) Appreciate the concepts of establishing a related business
f) Observe safety regulations and standards when performing tasks

Key Competence

At the end of this module, the trainee should be able to demonstrate ability to;

a) design and assemble electronics circuits
b) measure and control various physical quantities in process production plant
c) establish a business in the trade area

The units covered in this module are:

Code

17.2.0 Control Systems
18.2.0 Analogue Electronics II
19.2.0 Engineering Mathematics II
20.2.0 Digital Electronics
21.2.0 Engineering Drawing and Design
22.2.0 Industrial Programmable Logic controllers
23.2.0 Business Plan
24.2.0 Electric Circuit Analyses
25.2.0 Building Electrical Protection and Services
26.2.0 Electrical Power Generation and Transmission

17.2.0 CONTROL SYSTEMS

17.2.01 Introduction

This course module is aimed at providing the trainee with theoretical and practical understanding of control systems in the industries. A trainee undertaking this module unit require foundations of Mathematical concepts in Laplace transforms.

17.2.02 General Objectives

At the end of the module, the trainee should be able to:

a) Understand the principles of engineering control systems
b) Appreciate system response and performance
c) Analyze system's stability for a given control task.
d) Understand the need for compensation and use conventional techniques to compensate practical systems.
e) Apply analogue system simulation to solve systems' mathematical equations.
f) Understand the principles and applications of servo systems.

17.2.03 Module Unit Summary and Time Allocation

Engineering Control Systems

Code	Sub Module Unit	Content	Time Hrs
17.2.1	Introduction	• System terminology • Open and Closed loop	2
17.2.2	Block Diagrams	• Canonical form simplification	6
17.2.3	Signal Flow Graphs	• Conversion of block diagram to signal flow diagram • Simplification of system loop	6
17.2.4	System Modelling	• Need for modelling • Transfer functions for simple networks • Practical systems	6
17.2.5	System Performance	• Test signals • Dynamic responses • Damping	6
17.2.6	Stability	• Types of Stability • Routh's stability Criterion • Nyquist stability Criterion • Bode Plots	16

		• Nichol's Chart • Root Locus	
17.2.7	System compensation	• Need for compensation • Compensation networks • Design of compensation networks	8
17.2.8	Analogue computing and system simulation	• Need for simulation • Principles of an Operational Amplifier (Op-amp) • Op-amp arithmetic circuit • Solution of equations • Scaling	8
17.2.9	Servo Systems	• Servo mechanism • AC and dc servo amplifiers • Phase sensitive rectifiers • Thyristor controlled dc servo systems • Operation of stepper motors • Characteristics curves for servo motors • Calculations for given data	8
Total Time			**66**

17.2.1 INTRODUCTION TO CONTROL

Theory

17.2.1T0 *Specific Objectives*

By the end of the sub- module unit, the trainee should be able to:

a) explain control terms
b) compare and contrast open and closed loop systems

Content

17.2.1T1 Control system terms
- i) Control
- ii) System
- iii) Control system
- iv) Man-made system
- v) Natural system
- vi) Hybrid system
- vii) Controlled variable
- viii) Reference variable
- ix) Plant

17.2.1T2 Open and closed loop system
- i) Feedback
- ii) Features of open loop
- iii) Features of closed loop
- iv) Advantages and disadvantages

Competence

The trainee should have the ability to: identify and select types of control systems for electrical systems

Suggested teaching/Learning Activities

- Illustration
- Note taking
- Visits to industries

Suggested teaching/Learning Resources

- Sample practical control units

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.2 BLOCK DIAGRAMS

Theory

17.2.2T0 *Specific Objectives*

By the end of the sub module unit the trainee should be able to simplify control system block diagram

Content

17.2.2T1 Simplification of block diagrams
- i) Canonical form
- ii) Transfer functions
- iii) Superposition
- iv) Error ratio
- v) Primary feedback ratio

Competence

The trainee should have the ability to: establish the transfer functions for various basic and mechanical systems

Suggested teaching/Learning Activities

- Illustration
- Note taking

Suggested teaching/Learning Resources

- Sample practical control units
- Simulators

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.3 SIGNAL FLOW GRAPHS

Theory

17.2.3T0 *Specific Objectives*

By the end of the sub module unit the trainee should be able to:

a) convert block diagrams to flow diagrams
b) simplify system loops

Content

17.2.3T1 Conversion of block diagrams to flow diagrams
- i) Nodes
- ii) Sinks

17.2.3T2 Simplification of system loops
- i) Masons rule
- ii) Complex loop
- iii) Loop reduction

17.2.4 SYSTEM MODELLING

Theory

17.2.4T0 *Specific Objectives*

By the end of the sub- module unit, the trainee should be able to:

a) explain the need for systems modelling
b) derive transfer functions for simple networks and determine their transfer functions.
c) represent practical systems with transfer functions.

Content

17.2.4T1 Need for modelling

17.2.4T2 Derivation of transfer functions for simple networks
- i) Electrical
- ii) Mechanical
- iii) (S), jω, D operations

17.2.4T3 Presentation of practical systems
- i) Generators and Motors
- ii) Temperature control systems
- iii) Solving problem with given data

Competence

The trainee should have the ability to: convert block diagrams to signal flow diagrams

Suggested teaching/Learning Activities

- Illustration
- Note taking

Suggested teaching/Learning Resources

- Sample practical control units

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.5 SYSTEM PERFORMANCE

Theory

17.2.5T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to

a) describe test signals

b) explain the dynamic response of 1st and 2nd order systems
c) analyze the effects of various methods of damping

Content

17.2.5T1 Test signals
- i) Step
- ii) Velocity
- iii) Acceleration
- iv) Sinusoidal
- v) Unity impulse

17.2.5T2 Dynamic response for 1st and 2nd order systems
- i) Response terms
- ii) Standard 2nd order equation
- iii) Response graphs
- iv) Derive dimensional 2nd order equation

17.2.5T3 Damping methods
- i) Velocity feedback
- ii) Error rate
- iii) Viscous damping
- iv) Effects of damping ratio
- v) Calculations of limiting values

Suggested teaching/Learning Activities
- Illustration
- Note taking

Suggested Evaluation Methods
- Oral tests
- Timed written tests
- Assignments

17.2.6 STABILITY

Theory

17.2.6T0 specific objectives

By the end of the sub - module unit, the trainee should be able to:
a) explain types of stability
b) describe Routh's stability criterion
c) explain Nyquist diagrams
d) plot bode plot
e) construct Nichol's charts
f) sketch Root Locus diagrams

Content

17.2.6T1 Types of Stability
- i) Bounded input bounded output
- ii) Relative stability
- iii) Absolute stability

17.2.6T2 Routh's stability criterion
- i) Array formation
- ii) Determination of stability
- iii) Calculations

17.2.6T3 Nyquist diagrams
- i) Statement of Nyquist stability criterion
- ii) Nyquist diagram
- iii) Determination of gain and phase margins
- iv) Determination of gain and phase cross over frequency
- v) Calculation of a value K, required for stability
- vi) Description of type O, I, II and III of Nyquist systems
- vii) Sketches for open loop frequency

response for different systems

viii) Analyses of Inverse Nyquist curve

ix) Derivation of m and n circles

x) Determination of maximum value of M and and the frequency at which it occurs

xi) Determination of the relationship between M-circle and inverse Nyquist plot

xii) Evaluation of band width.

17.2.6T4 Bode plot

i) Logarithmic diagrams for simple systems asymptotes for magnitude

ii) Determination of:

iii) Phase and gain cross over frequency

iv) Phase and gain margins

v) Stability

vi) Output – input functions from a given asymptotic plots

17.2.6T5 Nichol's chart

i) Description of Nichol's chart

ii) Rectangular coordinates

iii) Identification of M and N circles

iv) Open loop frequency response curves

v) Determination of:

vi) Phase and gain margin

vii) M_{max} and ω_r

viii) Band width

ix) Closed loop frequency response

17.2.6T6 Root locus

i) Construction

ii) Analysis

Suggested teaching/Learning Activities

- Illustration
- Note taking

Suggested teaching and Learning Resources

- Text books
- Appropriate charts and graphs
- Equipment
- Mat lab programmes
- internet

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.7 COMPENSATION

Theory

17.2.7T0 Specific objectives

By the end of the sub - module unit, the trainee should be able to:

a) explain the need for compensating networks

b) derive transfer function of compensating networks

c) design compensating network

Content

17.2.7T1 Need for system compensation

17.2.7T2 Compensating networks transfer functions

17.2.7T3 Compensation network
- i) Lead
- ii) Lag
- iii) Lead lag
- iv) Design – bode
- Lead
- Lag
- Lead-lag
- Compensation using 3- term controller

17.2.7C Competence

The trainee should have the ability to: design compensating net works for control systems

Suggested teaching /learning resources

- Text books
- Equipment
- Appropriate charts and graphs
- Sample practical control units

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.8 ANALOGUE COMPUTING SYSTEM SIMULATION

Theory

17.2.8T0 *Specific objectives*

By the end of the sub - module unit, the trainee should be able to:

a) describe need for simulation
b) describe the principles of an operational amplifier
c) explain op-amp arithmetic circuit
d) solve equations using operational amplifiers
e) apply scaling methods

Content

17.2.8T1 Need for Simulation

17.2.8T2 Operation of Operational amplifier

17.2.8T3 Operational amplifier arithmetic circuit

17.2.8T4 Solution of equations using operational amplifier
- i) Summer
- ii) Inverter
- iii) Integrator
- iv) Differentiator
- v) Logarithmic amplifier
- vi) Comparator
- vii) Differential equations using Op Amp

17.2.8T5 Scaling method
- i) Amplitude
- ii) Time

Practice

17.2.8P0 *Specific objectives*

By the end of the sub module unit, the trainee should be able to assemble electronic circuit to carry out analogue computing techniques

Content

17.2.8P1 Analogue computing techniques
- i) Inverting
- ii) Integrating
- iii) Comparing
- iv) Summing
- v) Differentiating
- vi) Logarithmic

17.2.8C **Competence**

The trainee should have the ability to:

i) Interconnect analogue computer component to form a system

ii) Perform measurements on systems

Suggested teaching/Learning Activities

- Illustration
- Note taking
- Simulation

Suggested Teaching /Learning resources

- Text books
- Analogue computer components

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.9 SERVO SYSTEMS

Theory

17.2.9T0 *Specific objectives*

By the end of the sub - module unit, the trainee should be able to:

a) describe servo mechanisms

b) describe the difference between ac and dc servo amplifiers

c) explain phase sensitive rectifiers

d) explain the operation of thyristor controlled dc servo systems

e) explain the operation and control of stepper motors

f) sketch characteristics curves of ac and dc servomotors

g) solve stepper motor related problems

Content

17.2.9T1 Servo mechanisms

i) Position

ii) Speed

iii) Acceleration

17.2.9T2 Servo amplifiers

i) DC

ii) AC

17.2.9T3 Phase sensitive rectifier

iii) Synchros

iv) Applications

17.2.9T4 Operation of Stepper motors

i) Constructions

ii) Operations

iii) Control circuits

iv) Calculations

v) Interfacing

vi) Applications

17.2.9T5 Characteristics curves of ac and dc servomotors Sketching

17.2.9T6 Calculations

Practice

17.2.9P0 *Specific Objectives*

By the end of the sub-module unit the trainee should be able to:

a) carry out measurement of an ac and dc servomechanism

b) take measurements on the performance of a stepper motor

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17.2.9P1 Measurements on a Servomechanisms

17.2.9P2 Measurements Stepper motors

i) Phase tests

17.2.9C Competence

The trainee should have the ability to: use a servo motor in a control system

Suggested teaching/Learning Activities

- Illustration
- Note taking
- Practical exercises

Suggested Teaching /Learning resources

- Text books
- Servo motors
- Phase sensitive rectifiers

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments