**-SQA-SCOTTISH QUALIFICATIONS AUTHORITY**

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## NATIONAL CERTIFICATE MODULE DESCRIPTOR

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**-Module Number-** **0084558** **-Session-1988-89**
**-Superclass-** **XH**

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**-Title-** **PNEUMATIC SYSTEMS THEORY, DESIGN AND SERVICING (x 1 1/2)**

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**-DESCRIPTION-**

Purpose

This module is designed to develop a comprehensive knowledge of the theory and design of pneumatic systems and to develop skills in commissioning and servicing procedures.

It is aimed primarily at maintenance personnel and technicians requiring to extend their knowledge and skills.

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Preferred Entry Level

84553 Engineering Systems: Pneumatics
Standard Grade in Mathematics at Grade 3 Standard Grade in Physics at Grade 3

Learning Outcomes

The student should:

1. apply the appropriate theory in calculating the characteristics of compressed air and its behaviour in various industrial applications;

2. specify the components used in compressed air production and design the air distribution pipework for a given specification;

3. outline the design, construction, installation and operation of a range of pneumatic equipment;

4. carry out procedures for commissioning and servicing pneumatic systems.

Content/ Context

Corresponding to Learning Outcomes 1-4:

1. Imperial and SI units of force, weight, mass, pressure. The physics of air compression including the Gas Laws and the effect of changes in the pressure, volume or temperature of a gas. Definitions and calculations of work and power in pneumatics.

2. Types of Compressors: reciprocating piston and diaphragm, rotary vane and screw, dynamic centrifugal and axial flow.

   Compressor cooling systems, compressor controls, selection criteria.

   Components for production: filters, silencers, aftercoolers, water removal, drain traps, oil separators, air receiver and fittings, compressed air driers.

   Compressed air flow through pipework. Material selection, pipework sizing, joints and connections.

   Contamination, humidity, filtration, pressure regulation, lubrication.

3. Cylinders: types, construction, installation, selection requirements. Air motors. Direction control valves: poppet and spool, operating mechanisms, mid-position valves. Valve seals. Air-operated valves. Indirectly operated valves. Special valves: safety valves, pressure regulating valves, quick exhaust valves, non-return valves, shuttle valves.

4. ISO/BS symbols. Notation of pneumatic circuits. Speed control. Sequence control. Interlocking. Open and closed loop control. Methods of tackling a control problem. Practical examples of pneumatic system designs (e.g. conveying, materials handling, filling, weighing, alarm). Electro-pneumatic control using solenoids, pressure switches and micro switches; Hydro-pneumatics multi-signal control systems.

   Installation problems such as cleanliness, alignment, lubrication, conditioning, leakage, assembly procedures. Breakdown causes. Routine maintenance, compressor plant maintenance.

   Safety precautions applicable to tools, equipment and work areas including: safety valves in compressor installation, air receivers, care when disconnecting air lines, isolation of compressed air and electrical supplies during maintenance.

Flameproof equipment in inflammable atmospheres, dangerous practices in multi start arrangements. Safety notes on installing and maintaining pneumatic equipment. Dangers using compressed air.

Statutory testing requirements for Compressed Air receivers.

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Suggested Learning and Teaching Approaches

This module should be taught from the viewpoint of a maintenance engineer concerned with the operation of pneumatic systems who requires an in depth understanding of the theory and design of the elements of pneumatic circuits and ancillary components. Emphasis should be given to commissioning and servicing.

Safety and safe working practices should form an integral part of all instruction. Most of the learning outcomes can be achieved by project work and practical assignments.

A laboratory with training kits on which real valves, cylinders and other pneumatic equipment can be assembled and demonstrated is strongly recommended.

Sectioned components and polarised diagrams can also be used to explain the operating principles of components.

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Assessment Procedures

All Learning Outcomes must be validly assessed.

Acceptable performance in the module will be satisfactory achievement of all the performance criteria specified for each Learning Outcome.

The following abbreviations are used below:

LO Learning Outcome
IA Instrument of Assessment
PC Performance Criteria

LO1 APPLY THE APPROPRIATE THEORY IN CALCULATING THE CHARACTERISTICS OF COMPRESSED AIR AND ITS BEHAVIOUR IN VARIOUS INDUSTRIAL APPLICATIONS

PC The student:

(a) explains how compressed air is measured using SI and Imperial Units;
(b) describes how pressure terms are derived in pneumatics;

(c) performs calculations for practical applications using compressed air theory.

IA Restricted Response Questions

The student will be presented with restricted response questions which test understanding of knowledge of units of measurement, pressure terms, Gas Laws and compressed air theory and the applications of these features in a series of industrial applications.

The test will consist of 12 questions allocated as follows:

(a) Units -2
(b) Pressure -4
(c) Compressed Air Theory (including calculations)-6

Satisfactory achievement of the Learning Outcome will be demonstrated by the student producing for (a) 1 correct response, for (b) 2 correct responses, and for (c) 5 correct responses

LO2 SPECIFY THE COMPONENTS USED IN COMPRESSED AIR PRODUCTION AND DESIGN THE AIR DISTRIBUTION PIPEWORK FOR A GIVEN SPECIFICATION

PC The student:

(a) selects the components within the compressed air production unit to meet a given specification;
(b) selects the components within the compressed air distribution system for a given specification;
(c) designs the compressed air pipework system illustrating ring main assembly techniques to meet a given specification;
(d) uses appropriate information from manufacturers' catalogues and other relevant data.

IA Assignment

The student will be presented with an assignment involving the production of a design solution to meet a practical air consumption requirement from a given specification.

The specification will include details of flow requirements for a factory ring mains system distributing air to a number of work stations with varying requirements. It will also contain reference to the environment of the compressor installation location.

The assignment will involve the determination of a compressor installation system and distributive network.

Satisfactory achievement of the Learning Outcome will be demonstrated by the student satisfying all items on the following checklist.

CHECKLIST

1. Selecting appropriate compressor plant and components from various manufacturers' information.
2. Identifying installation components and construction of a block diagram.
3. Selecting materials and fittings for compressed air pipework system.
4. Calculating pipework system sizes.
5. Selecting components within the compressed air pipework system.
6. Using ring mains assembly techniques.

LO3 OUTLINE THE DESIGN, CONSTRUCTION, INSTALLATION AND OPERATION OF A RANGE OF PNEUMATIC EQUIPMENT

PC The student for each of the following:

(a) cylinders and motors;
(b) direction and control valves;
(c) valve operating mechanisms;
(d) hydro-pneumatics and low pressure sensing systems;

(I) describes the essential design features;
(ii) describes the basic composition;
(iii) explains the essential installation requirements;
(iv) explains the basic operation.

IA Structured questions

The student will be presented with structured questions which test the understanding of design features, construction elements, installation requirements and operating mechanisms of cylinders, motors, valves hydro pneumatics and low pressure sensing systems. The questions should include calculations for a selection of these components.

The test will consist of 11 questions allocated as follows:

(a) cylinders and motors - 3
(b) valves - 3
(c) valve operating mechanisms - 2
(d) hydro-pneumatics and low pressure sensing systems - 3

Each question should have 4 parts allocated to (i) to (iv) above.

Satisfactory achievement of the Learning Outcome will be demonstrated by the student producing 2 correct responses to each of (a) (b) (c) and (d).

LO4 CARRY OUT PROCEDURES FOR COMMISSIONING AND SERVICING PNEUMATIC SYSTEMS.

PC The student:

(a) follows the correct procedures to commission a pneumatic system;
(b) carries out routine servicing specified in manufacturers' information;
(c) carries out a maintenance inspection as specified in manufacturers' information;
(d) uses appropriate tools for the task;
(e) completes appropriate documentation to satisfy manufacturers' requirements.
(f) works in a logical sequence and follows all safety requirements relevant to the task including statutory testing requirements.

IA Assignment

The student will be presented with an assignment set under workshop conditions to test the application of knowledge and skills required to carry out procedures for commissioning and servicing a pneumatic system.

The assignment will be undertaken under observation on one pneumatic system which includes: a compressor installation providing air under pressure to at least 2 double acting cylinders via a mains distribution system, associated valves and switches to give a simulated clamp feed and work action.

Satisfactory achievement of the Learning Outcome will be demonstrated by the student satisfying all items on the following checklist.

CHECKLIST.

1. Commissioning compressor installation to produce a compressed air supply to specification.
2. Observing procedures for routine testing of installation.
3. Checking air intake filter, delivery pressure and temperature, lubricating oil level, drain valves and other items on a maintenance check list supplied.
4. Carrying out service on equipment and completing the service schedule.
5. Using appropriate tools for the task.
6. Working in logical sequence and observing correct safety procedures.