**-SQA-SCOTTISH QUALIFICATIONS AUTHORITY**

**Hanover House**
**24 Douglas Street**
**GLASGOW G2 7NQ**

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## NATIONAL CERTIFICATE MODULE DESCRIPTOR

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**-Module Number-** **0084557** **-Session-1988-89**
**-Superclass-** **XH**

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**-Title-** **HYDRAULIC 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 hydraulic 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

84554 Engineering Systems: Hydraulics
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 pressurised hydraulic fluids and their behaviour in various industrial applications;

2. specify the components used in a fluid reservoir power pack and design the hydraulic circuit distribution pipework for a given specification;

3. outline the design, construction, installation and operation of hydraulic pumps, motors, cylinders, and valves;

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

Content/ Context

Corresponding to Learning Outcomes 1-4:

1. Imperial and SI units of force, weight, mass, pressure. Pascal's Law and Bernoulli's Equation. Definitions and calculations of work and power in hydraulic systems. Properties and characteristics of hydraulic fluids, viscosity, viscosity index and relationships with temperature and pressure. Fluid types; oxidation, cavitation.

2. Main functions and capacity calculations for fluid reservoirs. Removal of impurities and types of filters for hydraulic fluids. Importance of filter locations. Temperature control of hydraulic fluids. Advantages, limitations and selection of various materials, fittings and joints used for hydraulic circuits. Calculations of pipework sizes and friction losses. Factors of safety; accumulators; functions, types and safety precautions regarding charging.

3. BS and ISO hydraulic symbols. Hydrodynamic and hydrostatic pumps. Function and type of hydraulic pumps and motors. Construction and operation of commonly used pumps and motors for hydraulic systems. Selection criteria. Construction and advantages of combination pumps. Types and construction of cylinders. Cylinder seals. Cushions. Installation. Calculations for cylinders. Directional control valves, construction and design of poppet and spool types. Operating mechanisms. Electrical and indirect operation.

   Pressure gauges, pressure relief and reducing valves, pressure control valve variations, subplates and cartridge systems.

   Flow control theory and compensating valves. Flow control methods. Flow meters. Remote control valves.

4. Filter locations. Two pump circuits. Two pressure and venting circuits. Accumulator circuits incorporating safe discharge. Reciprocating and regenerative circuits. Hydrostatic drives. Open and closed circuits. Safe release of excess pressure due to load momentum. Deceleration, sequence and clamping circuits. Open and closed loop controls. Servo and proportional valves and associated controls. Feedback. Amplifier symbols. Elements in the control chain, working and control energy. Selection criteria. Motion and control diagrams. Calculations for pressure loss and component dimensions. Variable displacement and reversible pumps. Pressure relief and replenishment in hydrostatic transmissions.

Maintenance problems associated with installation and commissioning. Fluid sampling. Filter membranes. Electrostatic purification. Routine and preventative maintenance. Troubleshooting charts. Safety precautions applicable to tools, fluids, equipment and work areas. Safe working pressures. Fire retardant fluids. Accumulator safety procedures. Flame proof equipment. Isolation of supplies. Overload protection. Safety regulations relating to pressure vessels. Safe start procedures.

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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 equipment who requires an in depth understanding of the design and manufacture theory of the elements of hydraulic circuits. Emphasis should be given to commissioning and servicing of hydraulic equipment.

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 hydraulic 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 PRESSURISED HYDRAULIC FLUIDS AND THEIR BEHAVIOUR IN VARIOUS INDUSTRIAL APPLICATIONS

PC The student:

(a) explains how hydraulic pressure is measured using SI and Imperial units;

(b) performs calculations using Bernoulli's equation and the continuity equation incorporating their derivatives;
(c) explains the factors affecting the selection of a hydraulic fluid to suit a specific application;
(d) describes the factors affecting fluids under pressure.

IA Restricted Response Questions and Multiple Choice Questions.

The student will be presented with questions to test the understanding of knowledge of units of measurement, hydraulic theory, fluid selection and factors affecting fluids under pressure and the behaviour of these elements in a series of industrial applications.

The test will consist of 14 restricted response questions and 7 multiple choice questions allocated as follows:

(a) units 5 restricted response
(b) Bernoulli and 4 restricted response Continuity equations
(c) fluid selection 5 restricted response
(d) factors affecting 7 multiple choice fluids under (each question having 3 pressure distracters and 1 key)

Satisfactory achievement of the Learning Outcome will be demonstrated by the student producing:

for (a) 4 correct responses;
for (b) 3 correct responses;
for (c) 4 correct responses, and
for (d) 6 correct responses.

LO2 SPECIFY THE COMPONENTS USED IN A FLUID RESERVOIR POWER PACK AND DESIGN THE HYDRAULIC CIRCUIT DISTRIBUTION PIPEWORK FOR A GIVEN SPECIFICATION

PC The student

(a) selects the components within the power pack and fluid reservoir for a given specification;
(b) selects the components within the hydraulic distribution system for a given specification;
(c) describes the basic operation of the fluid conditioning equipment;
(d) designs the hydraulic circuit distribution pipework for a given specification;
(e) 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 for a power pack and fluid reservoir and hydraulic circuit from a given specification.

The specification will include details of pressure and fluid flow requirements for an industrial installation distributing fluid by means of a hydraulic circuit to a number of work stations with varying requirements.

The assignment will involve the determination of the power pack and fluid reservoir and hydraulic circuit incorporating fluid conditioning equipment including accumulators to meet the given specification.

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

CHECKLIST

1. Calculation of tank capacity and selection of a hydraulic power pack from various manufacturers' information.
2. Selection of filters for different positions in the reservoir and distribution system.
3. Selection of heat exchangers and accumulator.
4. Selection of hydraulic circuit materials and fittings.
5. Calculation of pipework system sizes.
6. Calculation of total pressure drop through a hydraulic distribution system (pipes, bends, valves, filters) using information from manufacturers' catalogues and other relevant data.

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LO3 OUTLINE THE DESIGN, CONSTRUCTION, INSTALLATION AND OPERATION OF HYDRAULIC PUMPS, MOTORS, CYLINDERS AND VALVES

PC The student for each of the following:

(a) pumps and motors;
(b) actuators;
(c) direction control valves;
(d) pressure and flow control valves.

(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, element construction installation requirements and operating mechanism of pumps, motors, actuators, direction control, pressure and flow control valves. The questions should include calculations for a selection of these components.

The test will consist of 16 questions allocated as follows:

| | | |
|---|---|---|
| (a) | pumps and motors | 4 |
| (b) | actuators | 4 |
| (c) | direction control valves | 4 |
| (d) | pressure and flow control valves | 4 |

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

Satisfactory achievement of the Learning Outcome will be demonstrated on the student producing 3 correct responses to each of (a) to (d).

LO4 CARRY OUT PROCEDURES FOR COMMISSIONING AND SERVICING HYDRAULIC SYSTEMS

PC The student:

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

The assignment will be undertaken under observation on one hydraulic system which includes: a pump/reservoir assembly providing fluid to at least 2 double acting cylinders via associated valves and switches to give a simulated clamp, feed and work action. An accumulator pump unloading arrangement should also be included.

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

CHECKLIST

1. Commissioning the system to operate in accordance with specification.
2. Observing procedures for routine testing of installation.
3. Checking reservoir fluid level and cleanliness.
4. Carrying out service on equipment and completing the service schedule.
5. Using appropriate tools for the task.
6. Observing correct safety procedures.