NATIONAL CERTIFICATES (VOCATIONAL)

SUBJECT GUIDELINES

STORED PROGRAMME SYSTEMS

NQF Level 4

April 2008

STORED PROGRAMME SYSTEMS - LEVEL 4

CONTENTS

INTRODUCTION

A. What is Stored Programme Systems?

This subject covers application of practical analytical and design experience and is intended to develop the student to design, assemble and commission mechatronic systems in the manufacturing application technical field. It will equip the student with skills to apply a design process, assembling and commissioning skills for maintaining the production of quality services.

B. Why is Stored Programme Systems important in the Mechatronics programme?

This subject contains trade specific skills, knowledge, attitudes and values to equip learners sufficiently to enable them to participate in the maintenance, repair and installation of mechatronic systems in the workplace.

C. The link between the Learning Outcomes for Stored Programe Systems and the Critical and Developmental Outcomes

The application of this subject is OBE orientated and relates to the following critical and developmental outcomes:

- Identify and solve problems in which responses display that responsible decisions using critical and creative thinking have been made.
- Work effectively with others as a member of a team, group organization, community.
- Organise and manage oneself and one's activities responsibly and effectively.
- Collect, analyse, organise and critically evaluate information.
- Communicate effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation.
- Use science and technology effectively and critically, showing responsibility towards the environment and the health of others.
- Demonstrate an understanding of the world as a set of related systems by recognizing that problem-solving contexts do not exist in isolation.
- Contribute to the full personal development of the student.

D. Factors that contribute to achieving Stored Programme Systems Learning Outcomes

- An understanding of the PC being an essential part of future mechatronic systems
- Ability to connect and troubleshoot on PC and PLC networks
- Ability to use the computer to gather, process and communicate information
- Analytical ability
- Ability to do mathematical calculations and manipulations
- Hand-skills (specifically assembly work)
- Practical improvisation abilities.

1 DURATION AND TUITION TIME

This is a one-year instructional programme comprising 200 teaching and learning hours. The subject may be offered on a part-time basis provided the student meets all the assessment requirements.

Students with special education needs (LSEN) must be catered for in a way that eliminates barriers to learning.

2 SUBJECT LEVEL FOCUS

- Understand communication systems used in stored program automation systems.
- Select, apply and install bus systems in integrated industrial control applications.
- Interface, set up and programme related bus systems in advanced industrial PLC mechatronic applications.
- Create, test, debug and network PLC source control programs to an industrial automated system.
- Maintain and commission complex networked PLC based industrial control systems.

3 ASSESSMENT REQUIREMENTS

3.1 Internal assessment (50 percent)

3.1.1 Theoretical component

The theoretical component forms 40 percent of the internal assessment mark.

Internal assessment of the theoretical component in Stored Programme Systems Level 4 takes the form of observation, class questions, group work, informal group competitions with rewards, individual discussions with students, class, topic and semester tests and internal examinations. Lecturers can observe students when marking exercises from the previous day and asking class questions.

Assignments, case studies and tests can be completed at the end of a topic. Tests and internal examinations must form part of the internal assessment.

3.1.2 Practical component

The practical component forms 60 percent of the internal assessment mark.

Practical components include applications and exercises. All practical components must be indicated in a Portfolio of Evidence (PoE).

Internal assessment of the practical component in Stored Programme Systems Level 4 takes the form of assignments, practical exercises, case studies and practical examinations in a simulated business environment.

Students may complete practical exercises daily. Assignments and case studies can be completed at the end of a topic. Practical examinations can form part of internal practical assessment.

- **Some examples of practical assessments include, but are not limited to:**
  - Presentations (lectures, demonstrations, group discussions and activities, practical work, observation, role-play, independent activity, synthesis and evaluation)
  - Exhibitions by students
  - Visits undertaken by students based on a structured assignment task
  - Research
  - Task performance in a “Structured Environment”

- **Definition of the term "Structured Environment"**

For the purposes of assessment, "Structured Environment" refers to a simulated workplace or workshop environment. Activities in the simulated workplace or environment must be documented in a logbook with a clear listing of the competencies to be assessed. The following information must be contained in the logbook:

- Nature of department or environment in which practical component was achieved
- Learning Outcomes
- Activities in the environment with which to achieve the Learning Outcomes
- Time spent on activities
- Signature of facilitator or supervisor and student

For the logbook to be regarded as valid evidence, it must be signed by an officially assigned supervisor.

- **Evidence in practical assessments**

All evidence pertaining to evaluation of practical work must be reflected in the student's Portfolio of Evidence. The tools and instruments used for the purpose of conducting these assessments must be part of the evidence contained in the PoE.

3.1.3 Processing of internal assessment mark for the year

A year mark out of 100 is calculated by adding the marks of the theoretical component and the practical component of the internal continuous assessment (ICASS).

3.1.4 Moderation of internal assessment mark

Internal assessment is subject to internal and external moderation procedures as set out in the *National Examinations Policy for FET College Programmes*.

3.2 External assessment (50 percent)

A national examination is conducted annually in October or November by means of a paper(s) set and moderated externally. The practical component will also be assessed.

External assessment details and procedures are set out in the *Assessment Guidelines: Stored Programme Systems Level 4.*

4 WEIGHTED VALUES OF TOPICS

	TOPICS	WEIGHTED VALUE
1	Describe and apply communication systems used in stored programme automation systems	20%
2	Select, apply and install bus systems in integrated industrial control applications	20%
3	Interface, set up and programme related bus systems in advanced industrial PLC mechatronic applications	20%
4	Create, test, debug and network PLC source control programs to an industrial automated system	20%
5	Maintain and commission networked PLC based industrial control systems	20%
	TOTAL	**100**

5 CALCULATION OF FINAL MARK

Internal assessment mark: Student's mark/100 x 50 = a mark out of 50 (a)

Examination mark: Student's mark/100 x 50 = a mark out of 50 (b)

Final mark: (a) + (b) = a mark out of 100

All marks are systematically processed and accurately recorded to be available as hard copy evidence for, amongst others, reporting, moderation and verification purposes.

6 PASS REQUIREMENTS

A student must obtain at least fifty percent in internal continuous assessment and fifty percent in the examination to achieve a pass in this subject.

7 SUBJECT AND LEARNING OUTCOMES

On completion of Stored Programme Systems Level 4, the student should have covered the following topics:

Topic 1: Describe and apply communication systems used in stored programme automation systems
Topic 2: Select, apply and install bus systems in integrated industrial control applications
Topic 3: Interface, set up and programme related bus systems in advanced industrial PLC mechatronic applications
Topic 4: Create, test, debug and network PLC source control programs to an industrial automated system
Topic 5: Maintain and commission networked PLC based industrial control systems

7.1 Topic 1: Describe and apply communication systems used in stored program automation systems

7.1.1 Subject Outcome 1: Describe and apply Communication Systems

Range: Data communication; Modulator/ demodulators; Networking (LAN, WAN); Protocols; Interfacing; Field bus systems; (profibus, interbus, S, ASI bus); Industrial Ethernet technology; field bus software. Communication media utilised (co-axial, fibre optic, twisted pairs); SCADA software.

Learning Outcomes:

The student should be able to:

- Explain what is meant by
  - data communication in industry
  - interfacing
  - protocols as used in industrial networked applications
  - modulation/ demodulation
  - synchronous and asynchronous communication
- Explain
  - what networking is
  - various sub-systems of networking
- Describe and explain
  - the hierarchies of networked systems
  - the flow of information in complex mechatronic systems
  - measuring techniques used in networked systems
- Explain what is meant by field bus topology
- Explain the fundamental differences between the various field bus systems
- Explain industrial Ethernet technology
- Describe communication systems as used in industry by selecting the correct system for specific application
- Choose the correct information flow medium
- Apply integrated control of a manufacturing concern using a host computer and control software.

7.2 Topic 2: Select, apply and install bus systems in integrated industrial control applications

7.2.1 Subject Outcome 1: Describe and install field bus control applications

Range; Transfer, sorting, measurement, palletising, processing, robot assembly, automated warehouse, quality assurance.

Learning Outcomes:

- Describe
  - the advantages of using field bus technology in hybrid manufacturing systems
  - the various control applications that are used in manufacturing system applications
  - the importance of industrial robots as used in manufacturing system applications and the advantages and disadvantages thereof
- Arrange and connect field bus control components
- Connect the various signal transfer media
- Select field bus control equipment in accordance with cost and/or function
- Read, interpret and produce field bus control application diagrams
- Interconnect hybrid manufacturing control applications in flexible manufacturing systems
- Plan field bus control applications
- Prepare all the required documentation
- Ensure that safety has been considered
- Install in accordance with regulation

7.3 Topic 3: Interface, set up and programme related bus systems in advanced industrial PLC mechatronic applications

7.3.1 Subject Outcome 1: Configure and programme an advanced PLC system in manufacturing system control applications

Learning Outcomes:

The student should be able to:

- List various programming languages used in advanced control programming
- Explain the procedure for safely interfacing the control medium
- List and explain the various safety aspects that must be considered when working with control applications
- Configure and set up various integrated control applications in a manufacturing system application
- Produce the programming sequence using one of the programming aids
- Programme the industrial PLC for correct function using one of the listed programming languages

7.4 Topic 4: Create, test, debug and network PLC source control programs to an industrial automated system

7.4.1 Subject Outcome 1: Describe and apply mechatronic automated manufacturing systems

Range: Documentation: Single line diagrams, equipment position diagram, terminal diagram, interconnection diagram, program listing, operational instructions, technical manual, functional description.
Terms: Verbal description, sequence diagram of switching algebra, program flow chart, status or function line, signal line.

Learning Outcomes

- Describe
  - the fundamental documentation required for an integrated mechatronic system
  - mechatronic system related terms
  - the function and procedure of PLC diagnostic program types
- Review and interpret specifications, plan and integrate manufacturing system applications into an integrated hybrid system
- Test and adjust installation for correct function
- Apply PLC diagnostics

7.5 Topic 5: Maintain and commission networked PLC based industrial control systems

7.5.1 Subject Outcome 1: Commission faults in integrated systems

Range: Commissioning process requirements

Learning Outcomes:

The student should be able to:

- List and describe the requirements for the commissioning process in complex systems
- Set goals for standardisation
- Define what is meant by the term *commissioning*
- List the actual conditions of commissioning guidelines
- Describe
  - structuring of products for easy commissioning (purpose, preliminary testing and commissioning)
  - methods of structuring products for easy commissioning
  - the possible fault terms used during the commissioning process (fault, malfunction, function, disturbance)
  - damage classes, commissioning faults and component faults
  - trouble shooting methods (determination-asking questions, systematic approach using tools, correction and repair procedure)
  - tools for repair (program flow charts, sequential function, function charts, circuit diagrams)
- Apply various troubleshooting tools to perform commissioning of PLC application control programs
- Plan maintenance required for various hybrid manufacturing system applications

8 RESOURCE NEEDS FOR THE TEACHING OF STORED PROGRAMME SYSTEMS - LEVEL 4

8.1 Physical resources

- **Infrastructure (building infrastructure, fixtures, networks)**

  Well equipped workshops are essential for this practically orientated subject. If possible, using the facilities of employers in the manufacturing field for training purposes is preferred.

  - Building to be appropriately designed for workshop types and/or laboratory type presentations that comply with building regulations and safety standards.
  - The tables below show broadly the laboratory and work area requirements, related training equipment for allocated students and the relevant facilitator training that may be required for the delivery of this vocational training:

	Mechatronics (Vocational Training)	
1	**ELECTRICAL INSTALLATION AND MACHINE LABORATORY**	for 20 learners
1a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	1
1b	**Electrical installation**	
	Safety and protection	2
	Industrial installation and control	2
1c	**Electrical Machines**	
	DC machines	2
	AC machines	2
	Three phase machines	2
	Fault simulator three phase machines	2
	Frequency drives (three-phase machines)	2
1d	**Commissioning and training**	
	Teacher training - electrical	1
2	**MOTION AND CONTROL LABORATORY**	
2a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	General	1
	Computer hardware	10
2b	**Pneumatics**	
	Basic pneumatics	5
	Advanced pneumatics	5
	Workstation pneumatics	2
	Software pneumatics	20

2c	**Electro-pneumatics**	
	Basic electro-pneumatics	5
	Advanced electro-pneumatics	5
	Measurement in pneumatics	2
	Workstation – electro-pneumatics	2
2d	**Hydraulics**	
	Basic hydraulics	5
	Workstation hydraulics	1
	Software hydraulics	20
2e	**Electro-Hydraulics**	
	Basic electro-hydraulics	2
	Advanced electro-hydraulics	2
	Workstation electro-hydraulics	1
2f	**Sensor Technology**	
	Proximity sensors	2
	Distance and displacement sensors	2
	Force and pressure sensors	2
	Workstation sensor technology	2
2g	**Basic and Advanced PLC**	
	Advanced PLC	2
2h	**Fieldbus and electric drives**	
	Fieldbus profibus-DP	2
	Electro-servo drives	2
	Electro-stepper drives	2
	Workstation fieldbus and drives	1
2i	**Commissioning and training**	
	Teacher training – Motion and control	1
3	**ELECTRONIC AND SOFTWARE LABORATORY**	
4a	**Classroom Facilities**	
	Workplace	20
	Teaching	20
	Computer hardware	20
3b	**Courses**	
	Desktop laboratory	20
	Electrical engineering	20
	Electronics	20
	Project work	20

3c	**Advanced Courses**	
	Digital Electronics	3
	Microcomputer	3
	Power electronics	3
	Electrical machines	3
	Communication technology	3
3d	**E-learning**	
	Electronics	3
	Mechatronics	20
3e	**Commissioning and Training**	
	Teacher training	1
4	**CNC AND CIM/ FMS LABORATORY**	
4a	**Classroom facilities**	
	Workplace	20
	General	20
	Computer hardware	1
4b	**CNC Manufacturing**	
	CNC turning	1
	CNC milling	1
	CNC trainers and CAD/ CAM	1
4c	**Manufacturing System –Production Modules**	
	Manufacturing system- Pallet transport	1
	Manufacturing system- Material input	1
	Manufacturing system- Material output	1
	Manufacturing system- Processing	1
	Manufacturing system-Assembly	1
	Manufacturing system- Automated warehouse	1
	Manufacturing system-Quality assurance	1
	Manufacturing system-Control	1
	Manufacturing system-Programming	1
4d	**Commissioning and training**	
	Teacher training – CIM/ Manufacturing system	1
5	**COMPUTER LABORATORY**	
5a	**Classroom facilities**	
	Workstations	20
	Computer hardware	20
	Software (Microsoft Office)	20
	Internet access	20
6	**CENTRAL TOOL STORE**	
7	**ABLUTIONS**	

8.2 Equipment and machinery

The equipment as indicated above is the suggested minimum although other equipment can be used to obtain the same outcomes. Access by the student and lecturer to the above listed equipment and machinery is essential. Machinery and laboratory equipment as listed above is essential in the delivery of vocational training for Mechatronics.

8.3 Human resources

- The minimum qualification requirements for educators who deal with the learning and teaching of this subject will be qualification as a mechatronic mechanician/ technician/ technologist, or in one or more of the following sub-fields: electrician, electrician (signals), millwright, IT specialist, etc.
- Lecturers should ideally be qualified as educators capable of teaching up to NQF level 6 at least. They should be creative and have a sound knowledge of learner centred education.
- It is essential that educators working in this environment attend seminars and upgrading workshops regularly in order to be updated and re-skilled in respect of the latest developments in technology.
- The recommended number of students for workshop practice is 20.

8.4 Financial resources

The institution should make provision for workshop practice consumables during practical training, maintenance of physical resources, purchasing of new equipment and finance to hire external providers.