[C032/SQP103]

Higher Manufacturing

Time: 3 hours

NATIONAL QUALIFICATIONS

Specimen Question Paper

100 marks are allocated to this paper.

Attempt **all** questions in Section A (40 marks).

Attempt **three** questions in Section B (60 marks).

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Marks

SECTION A

Attempt ALL questions in this Section (total 40 marks)

1. The holes shown in the component below in Figure Q1 are to be produced on a point to point numerically controlled drilling machine.

Calculate the rectangular co-ordinates of A, B, C, D and E from the datum point to complete the table shown in **Worksheet Q1**. **(4)**

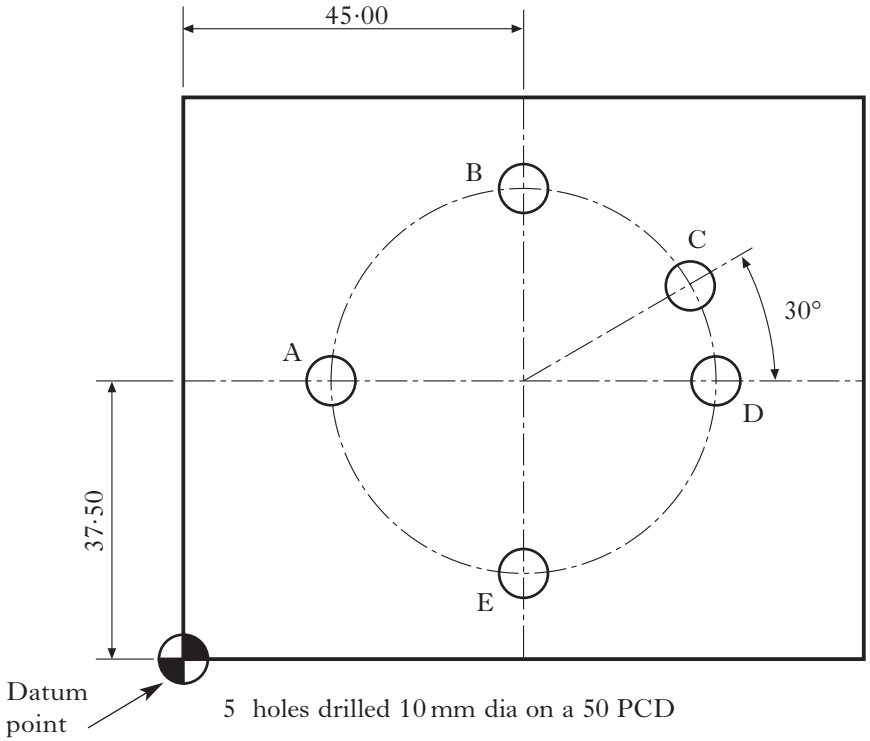


Figure Q1

2. A sheet metal component can be manufactured using a press tool or a CNC punch.

Use the following data to establish the minimum number of components to justify the cost of the press tool. **(5)**

	Press Tool	*CNC Punch*
Tooling cost (£)	3000	0
Cycle time (s)	1·5	12
Machine rate (£/h)	24	60

Marks

3. Explain what is meant by Post Processing for numerical control programming and why it is needed. **(4)**

4. Distinguish between Fixed Costs and Variable Costs in a manufacturing environment, quoting **one** example of each. **(4)**

5. The properties of many metals and alloys can be changed by heating them to specific temperatures and cooling them under controlled conditions at specified rates.

Describe **two** of the following heat treatment processes and give a reason why **each** could be used.

(i) Hardening

(ii) Tempering

(iii) Case hardening

(iv) Annealing **(4)**

6. Plastics processing can be thought of as "changing the shape of plastic and ensuring the change of shape is permanent".

Give a brief description of the process of injection moulding. **(4)**

7. Explain **four** advantages of using Programmable Logic Controllers. **(4)**

8. Explain why the following factors determine how a product is to be made.

(i) Size

(ii) Shape

(iii) Quantity

(iv) Quality **(4)**

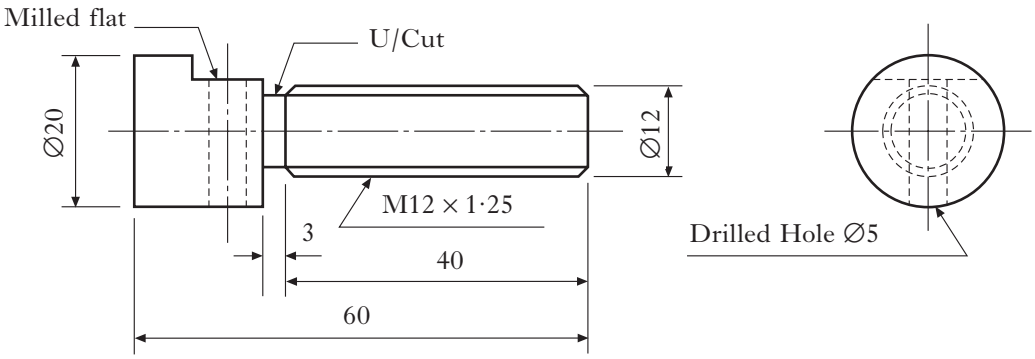
9. (*a*) The component shown below in Figure Q9 is to be machined using three separate machine tools. From the options listed below, select the correct sequence of machine tools. *Marks*

(i) Drill, Mill, Lathe

(ii) Drill, Lathe, Mill

(iii) Lathe, Drill, Mill

(iv) Lathe, Mill, Drill **2**



Material Mild Steel Bar ∅25 × 65 long

Figure Q9

(*b*) The component shown in Figure Q9 is to be produced from a mild steel billet 65 mm long. Identify the correct sequence of operations required to produce the component. **2**

(4)

10. Identify components in each of the following categories in a domestic central heating system.

(i) Inputs

(ii) Outputs **(3)**

Marks

SECTION B

Attempt any THREE questions in this Section (total 60 marks).
Each question is worth 20 marks

11. Automated materials handling is an important aspect in current manufacturing systems.

(*a*) Give **four** examples of this in practice. **8**

(*b*) Discuss **six** factors which should be considered when deciding whether manual or automated methods should be used in printed circuit board assembly. **12**

(20)

12. Many components used in the manufacture of goods such as cars, boats and aircraft are now made from materials which differ from those used in earlier models. **Worksheet Q12** gives one example of such a component, a fighter aircraft cockpit cover.

Select a further **two** components of your choice which will allow you to complete the table on **Worksheet Q12** to:

(*a*) identify the original materials and the current materials; **4**

(*b*) outline the main properties which make the current materials superior to the old ones; **8**

(*c*) state the changes in manufacturing methods associated with the new materials. **8**

Note: Your answers should include at least **two** different materials. **(20)**

13. A boat builder who has been making customised boats to order has decided to change direction and build smaller craft for the mass leisure industry. This decision is influenced by the results of a survey which indicated there was a demand for a large number of these vessels.

(*a*) (i) Describe the changes required in the manufacturing system to make it suitable for the new venture. **5**

(ii) List the implications of applying the changes described in part (i). **5**

(*b*) Explain the importance of quality assurance and quality control in this situation and how each of these could be implemented. **10**

(20)

14. In the role of a management consultant, you have to persuade the management of a manufacturing company that the introduction of a CAD CAM system would be beneficial.
Discuss **five** benefits you would suggest. **(20)**

[*END OF QUESTION PAPER*]

[C032/SQP103]

Higher Manufacturing

Specimen Marking Instructions

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Higher Manufacturing

Specimen Marking Instructions

SECTION A

1

Hole	X co-ordinate	Y co-ordinate	Marks
A	20	37.5	–
B	45	62.5	– 2
C	66.65	50	–
D	70	37.5	–
E	45	12.5	

(4)

2 Break-even when total cost of each process is the same.

Cycle times in seconds incompatible with machine rates in £/hour ∴ conversion needed

Total cost = Fixed cost + Variable cost

$$\therefore 3000 + N \frac{24}{60 \times 60} \times 1.5 = 0 + N \frac{60}{60 \times 60} \times 12$$

$$3000 + 0.01N = 0.2N$$

$$3000 = 0.019N$$

$$N = 15789$$

(5)

Note: Candidates may round this up to 16000

3 Post processing is the work carried out by a computer program which converts the tool/work geometric movements generated by a Graphical Numerical Control Program into a part program. This style of part program suits a particular machine controller. There are different post processor programmes for different machine controllers.

Post processors allow the use of computer simulation programmes which can portray on screen the tool and work movement used within the manufacturing process. In allowing this facility there are advantages, such as:

- use of simulation to check component shape and size without expensive use of a machine tool
- ease of error correction
- no need to calculate tangency points for a blended radius

(4)

Marks

4 Fixed costs are, for example, a factory s rates bill which is unaffected by the number of components produced.

Variable costs increase, often linearly, with volume of production eg material, direct labour. (4)

5 Solution — 2 of the following.

(i) Hardening

Steel is heated to the temperature appropriate for its carbon content. To harden the steel, it is quenched (cooled rapidly) from this temperature by immersing it in, eg water.

Hardening allows the steel to cut other metals and helps reduce abrasion and wear. 2

(ii) Tempering

Quench-hardened plain carbon steels are very brittle and unsuitable for immediate use. Tempering consists of reheating the hardened steel again and quenching it in water or oil. The component is gently heated to an appropriate temperature (colour) before quenching.

Tempering greatly increases the toughness of the component at the expense of some hardness. 2

(iii) Case Hardening

There is often a need for the surface of steel to be hard without the entire component being made hard.

Case hardening is processed by increasing carbon content in the outer skin of the material. This is then followed by the hardening process. 2

(iv) Annealing

Annealing is the heat treatment used to make a metal softer and more ductile.

It involves heating the metal to above the recrystallisation temperature and then slowly cooling it. 2

(4)

6 Polymers are supplied in powder or granular form which is fed into a hopper which directs the polymer to the machine barrel to be fed into the mould cavity by means of a ram or screw. Heat is generated to melt the polymer and make it easier to flow to all parts of the mould.

Pressure is applied by the ram or screw to fill the mould. Water is circulated around the mould to cool the polymer and form the component. Ejection follows after a suitably short time and the process is repeated. (4)

Marks

7 Solution — 4 of the following.

(i) PLCs are easy to install and program.
(ii) Access to PLCs can be restricted by hardware features such as keylocks, and by software features such as passwords.
(iii) They are reliable and some can survive and function in harsh conditions.
(iv) Speed of operation is much faster than electromechanical relays (approximately 10 times faster).
(v) Fault diagnosis is faster. Most are fitted with diagnostic indicators which monitor power supply, central control unit faults, input and output conditions and battery power. (4)

8 (i) The size of the workpiece to be manufactured will influence the size and construction of the machine. Sand castings are limited by the size of the moulds and the ability to pour steadily and not too slowly. 1

(ii) Machined parts usually divide into two types according to shape: round and prismatic. Round parts such as gears, disks, shafts, require turning and boring operations. Prismatic parts require milling and drilling operations. 1

(iii) Small quantities can be produced by customised methods.
Medium quantities can be produced by batch methods.
Large quantities can be produced by mass production methods. 1

(iv) Quality on manually operated machines requires operators to be highly skilled.
CNC machining will produce higher precision, greater repeatability and more complicated shapes. 1

(4)

9 (a) Solution is choice (iv) 2

(b) Solution

Face bar _ Turn 20mm dia to length _
Reverse, Face bar to length _ Turn 12mm dia to length _
Form undercut _ Cut thread _ Mill flat _ Drill 5mm dia hole 2

(4)

Marks

10 A domestic central heating system has the following inputs and outputs:

(i) Inputs

Cold water supply _
Thermostat setting _
Gas supply _
240v AC mains electricity _

(ii) Outputs

Heat from radiators _
Waste heat and combustion products _

(3)

SECTION B

Marks

11 (a)

Automated Handling device	**Example**
Automatic guided vehicle	Delivering tools and components to a machining cell
Robot	Assembly of visual display units
Dedicated pallets	Delivering work to a machining centre correctly oriented for the machining operation
Conveyor belts	Transferring pallets and workpieces between workstations

8

(b) The precision required to place surface mount devices is outwith the capability of an operator under production conditions.

Standardisation of components makes for easy and quicker fitting compared to selective assembly techniques.

Component parts must be capable of being picked, placed and fixed automatically by an industrial robot.

Only when large numbers of a component are being assembled can the cost of the design work and manufacturing accuracy be justified to ensure a high level of interchangeability and ease of assembly.

Robotic assembly will reduce unit costs by producing more assemblies in the same time as manual assembly but only if sufficient numbers are required.

A break-even diagram will indicate the numbers necessary to invest in robotic assembly.

The capital cost of installing robots
Ongoing cost of care and maintenance
Product life cycle
Availability of suitably skilled labour 12

(20)

Marks

‘

12 The answers to this question will be wide and varied. The table below gives 3 examples of the type of points which could be highlighted within the candidate s response.

Component	*Original Material*	*Current Material & Properties*	*Reasons for Current Material Selection*	*Differences in Manufacturing Methods*
Fighter aircraft cockpit cover	Aluminium frame with glass inserts	Thermosetting Polymer **Properties of:** Low weight ratio Transparency Strength	Reduction in overall aircraft weight. Pilot has improved all round vision. Strength of cover given through the manufacturing method.	New manufacturing method of injection moulding would be used.
Car speedometer electrical connections	Rubber or shellac connectors or covers	Composite such as Tufnol **Properties of:** Low weight ratio Ease of machining Good electrical insulation	Reduction in overall weight. Ease of machining therefore reduction of cost. Good electrical insulation resulting in lack of possible tracking.	Machined in a single machine setting consisting of: Facing Drilling Tapping Parting-off.
Car doors	Steel plate	Rolled Steel **Properties of:** Thinner section Greater malleability	Thinner section. Lightness. Ease of shaping. Greater strength due to manufacturing methods.	New manufacturing methods using press tools to form door shape and rib for strength.
Boat hull	Wood	Glass Reinforced Plastic **Properties of:** High strength to weight ratio Flexibility of shape Low maintenance	Layering of plastic netting to give greater strength & flexibility of shape. Dye impregnation for a lasting colour.	New manufacturing method using mould and layering & stippling of netting.
		(4)	(8)	(8)

(20)

Marks

13 (a) The manufacturing system in use at present is jobbing or customised. This would have to change to a mass/continuous production system of manufacture. A mass/continuous production system is one in which the equipment and workstations are arranged in a sequence according to the steps used to convert the input raw materials into the desired component or assembly. The implications in applying this type of system would be as follows: 5

- Initial increase of capital costs
- Need to fragment the skilled process into less complicated steps thus reducing the skill requirement. This can be achieved in many cases by the use of aids such as jigs or fixtures which also ensure the important factor of repeatability
- Need to create a production flow system with dedicated work stations, or work teams which would be established at relevant stages in the through-put of the product
- Need to create accurate scheduling of raw materials and bought in components
- Decrease in unit costs. 5

(b) Quality in a manufacturing context can be defined as the degree to which a product or its components conform to certain standards that have been specified by the designer. The design standards generally relate to the materials, dimensions and tolerances, appearance, performance, reliability and any other measurable characteristic of the product.

To ensure that its products adhere to the specified standards, a firm will generally organise its activities along two approaches — Quality Assurance and Quality Control. These two approaches represent the before and after in the firm s efforts to manage quality in manufacture.

- Quality Assurance is concerned with those activities, which will maximise the probability that the product and its components will be manufactured within the design specifications, eg the decision on material selection at product design to ensure best performance in terms of properties, durability, reliability, etc. In manufacturing, planning decisions relating to tooling, such as jigs and fixtures and processes, will all have influence on quality.

  The application of Quality Assurance would involve the practice of:

- Quality Control which is concerned with those activities related to inspection of product and component quality, detection of poor quality and corrective action necessary in feedback to manufacturing to eliminate poor quality.

  These activities also involve the planning of inspection procedures and the specification of gauges and measuring equipment needed to perform the inspections. Included within the scope of planning would be the design of statistical sampling plans, a field of study which is usually called statistical quality control.

10

(20)

Within the answers for this question the marker should be looking for a mention of the following in the candidate s response. Marks

System selection	Jobbing/Customising; Mass/Continuous; Capital costs; Unit costs; Reduction of Skill requirement; Jigs/Fixtures; Repeatability; Flow system; Dedicated work stations; Scheduling
Quality	Explanation of the following: Quality; Quality Assurance; Quality Control; Statistical Quality Control; Reason for applying Jigs and Fixture; Gauges.

14 A clear description of any five of the following:

improved design quality
increased productivity
improved communications
creation of a data base
standardisation
cost reduction
product quality
product development
the only way
company image
improved flexibility
financial justification
employee security. (20)

[END OF MARKING INSTRUCTIONS]

[C032/SQP103]

Higher Manufacturing

Time: 3 hours

NATIONAL QUALIFICATIONS

Specimen Worksheets
for Questions 1 and 12

Fill in these boxes and read what is printed below.

Full name of centre

Town

First name and initials

Surname

Date of birth
Day Month Year

Candidate number

Number of seat

To be inserted inside the front cover of the candidate's answer book and returned with it.

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WORKSHEET FOR QUESTION 1

Points	X Co-ordinate	Y Co-ordinate
A		
B		
C		
D		
E		

Table Q1

(4)

WORKSHEET FOR QUESTION 12

Component	*Original Material*	*Current Material & Properties*	*Reasons for Current Material Selection*	*Differences in Manufacturing Methods*
Fighter aircraft cockpit cover	Aluminium frame with glass inserts	Thermosetting Polymer **Properties of:** Low weight ratio Transparency Strength	Reduction in overall aircraft weight. Pilot has improved all round vision. Strength of the cover given through the manufacturing method.	New manufacturing method of injection moulding would be used.
		(4)	**(8)**	**(8)**

(20)