MANUFACTURING ENGINEERING TRIPOS PART I

Monday 26 April 2010 9 to 10.30

PAPER 2

Module 3P2: PRODUCTION MACHINES AND SYSTEMS

*Answer not more than **two** questions, **one** from each of sections **A** and **B**.*

*Answers to sections **A** and **B** must appear in two separate booklets.*

All questions carry the same number of marks.

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

There are no attachments.

STATIONERY REQUIREMENTS	SPECIAL REQUIREMENTS
8 page answer booklet x 2	Engineering Data Book
Rough work pad	CUED approved calculator allowed

You may not start to read the questions printed on the subsequent pages of this question paper until instructed that you may do so by the Invigilator

Final Version

SECTION A

1 (a) Sketch the side view of a single-point cutting tool in the process of cutting metal, showing a typical wear pattern. How is the extent of tool wear usually defined? [20%]

(b) State and explain the relationship between cutting speed and tool life. Sketch typical wear/time curves for a tool from initial use to tool failure to show the effect of different cutting speeds on the tool life. Indicate on the sketch, the point usually taken as the design life of the tool. [20%]

(c) Describe, with a sketch graph, how the hardness of a steel workpiece would be expected to influence tool life. Suggest a processing sequence to achieve a rapid production route for machined steel components with a high final hardness. [20%]

(d) Sketch a qualitative plot showing the effect of cutting speed on the total cost of machining each component in a production batch. Describe the different elements that make up the total cost of machining and suggest how you would optimise this cost. [40%]

2 (a) Define ‘accuracy’ and ‘precision’. Explain how each is quantified in the context of machining operations. [20%]

(b) Describe the factors that cause variation in workpiece dimensional accuracy during machining. Suggest, in each case, the measures which can be taken to minimise the variation. [35%]

(c) Describe the internal and external sources of dynamic disturbances during machining operations and their effects. How can we identify whether a disturbance is caused by internal or external sources? Explain how the effects of dynamic disturbances can be minimised. [45%]

SECTION B

3 (a) Describe corrective, preventive, and predictive maintenance strategies, and outline their advantages and disadvantages. [30%]

(b) Describe the 'bathtub curve' in the context of machine tool reliability. [25%]

(c) Compute the overall reliability of the system shown in Fig. 1, where the sub-system reliabilities are given by:

$R_1 = 0.80$, $R_2 = 0.90$, $R_3 = 0.92$, $R_4 = 0.95$, $R_5 = 0.90$, and $R_6 = 0.85$. [15%]

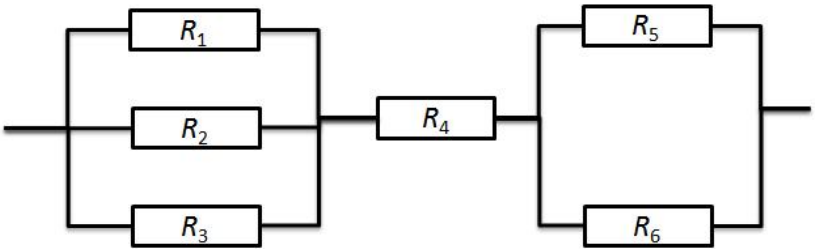

Fig. 1

(d) The hydraulic pump used in a machine tool becomes less efficient with usage. This results in an increase in the annual operating cost $c(t)$, which is given by the following equation:

$$c(t) = A - Be^{-kt}$$

Where, A = £2200, B = £1700, k = 0.3/year, and t is the age of the pump in years. The average cost of replacing the pump is £1200. What is the optimal replacement time for the pump? Explain the rationale behind your answer. [30%]

(TURN OVER

4 A Programmable Logic Controller (PLC) is commonly used for control and coordination of automated production cell operations, and ladder logic code (LLC) is a standard approach for producing control instructions for PLCs.

(a) Using an example, explain how XOR logic can be implemented in Ladder Logic Code. [20%]

(b) Using an example, explain how a timer can be implemented in Ladder Logic Code. [20%]

(c) Parts are transferred using a conveyor system as shown in Fig. 2. Parts are required to be redirected through the left and right routes alternately, and a gate that switches its position between AB and AC is used to achieve this. Part sensors S1, S2, and S3 are used to detect the presence of parts on different locations on the conveyor. The conveyor needs to be turned off when 10 parts have been transferred to each route.

The inputs to the operation are:

I1: Part sensor S1 activated
I2: Part sensor S2 activated
I3: Part sensor S3 activated
I4: Momentary contact push button to start conveyor

The outputs in the operation are:

O1: Conveyor motor ON
O2: Gate in position AB
O3: Gate in position AC

Generate a ladder logic code for this production operation. Also provide an explanation for each rung of the ladder you generate. [60%]

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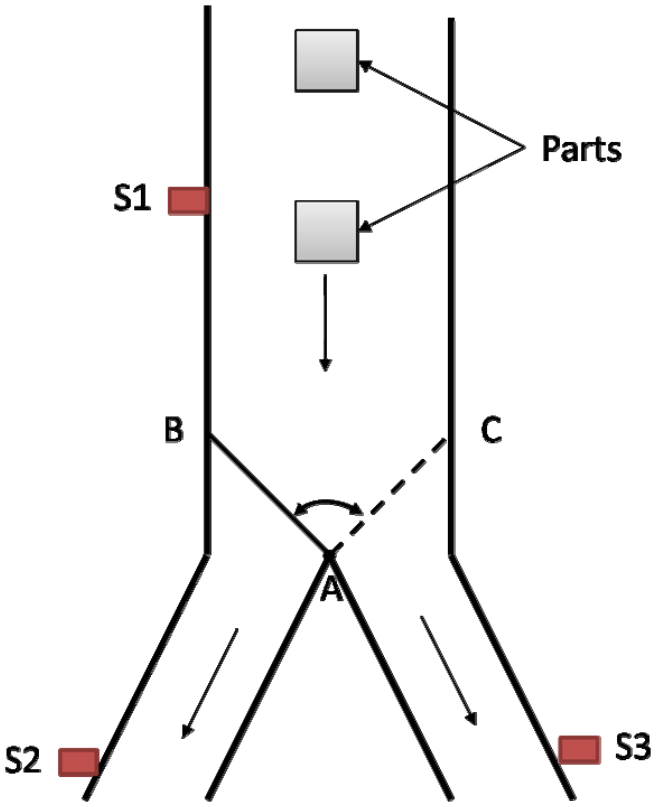

Fig. 2

END OF PAPER