

STAFFORDSHIRE UNIVERSITY
School of Engineering



Staffordshire
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Session 1992/93

BEng(Hons) in Computer Aided Engineering (BM4CH)

Computer Aided Manufacture

DATE: 9th June 1993
TIME: 2.00 pm - 5.00 pm
DURATION: 3 Hours 1,5,6,7,8

EXAMINER: T S Baines 5274
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Instructions to Candidates:

You are required to answer five questions only.
All questions carry equal marks.

Students Will Require:

1. A small manufacturing company produce a product (Part No A36) and Figures Q1(i) and Q1(ii) show an indented explosion for A36 and a stock list of items. Not all of the items in the stock list are used to make product A36. The company has formulated a Master Production Schedule and this is shown in Table Q1. Using all of the data provided, complete the following tasks:-

- (i) Sketch a product structure diagram for A36. (2 marks)
- (ii) Create a Material Requirements Plan for part Z49. Assume the company works seven days per week. (18 marks)

Use the blank MRP solution sheet provided to illustrate your answer.

Master Production Schedule		
Part	Order	Date
A36	5	10.3.93
A36	15	12.3.93
A36	20	15.3.93
X16	25	7.3.93

Table Q1

2. In recent years Optimised Production Technology (OPT) has caused considerable interest in manufacturing companies.

- (i) Critically appraise the basis of OPT. (10 marks)
- (ii) With respect to the OPT philosophy discuss the terminology "balanced plant". (4 marks)
- (iii) Discuss the aspect of OPT which is fundamentally opposed to Manufacturing Resource Planning (MRPII) philosophy? (6 marks)

3. (a) Discrete event simulation is one form of model that can be used to assess the performance of a manufacturing system. There are a variety of other options which could be used for this purpose. Present the forms of assessment that are available by showing a classification of modelling techniques.

(8 marks)

(b) Time series and histograms are two methods of graphically illustrating the performance of a simulation model. Distinguish between these forms of representing information and explain how each can be used in a simulation model.

(8 marks)

(c) Stochastic simulation models, such as the WITNESS factory model, use random number streams to characterise the models behaviour. Explain, therefore, how identical simulation models running on different computers will give the same results.

(4 marks)

4. (a) During the process of conducting a simulation study the activities of verification and validation need to be carried out. Distinguish between these two activities and position them in a flow diagram showing the overall sequence of a simulation study.

(8 marks)

(b) Consider the following statement:-

"Discrete Event Simulation packages, such as WITNESS, can be used to predict the future for a manufacturing system.

Discuss in detail the accuracy of this statement.

(12 marks)

5. The Just-in-Time (JIT) technique of production management has been defined as a "disciplined programme for comparing overall productivity and efficiency, and for reducing waste, in a manufacturing system environment".

Explain the philosophy of the Just-in-Time system and describe, in detail, how it can be successfully applied in industry. Give examples with which you are familiar and critically appraise the effectiveness of JIT, particularly for western industrial society.

(20 marks)

6. (a) Compare a Flexible Manufacturing System (FMS) with a "conventional" manufacturing system particularly with regard to real time materials handling and scheduling.

(4 marks)

- (b) Discuss briefly the economic justification of an FMS.

(4 marks)

- (c) Critically appraise the industrial implementation of an FMS, basing your discussion on a case study with which you are familiar.

Emphasise the problems which occurred during this implementation and the general benefits which arose from the introduction of the FMS in this situation.

(12 marks)

7. Figure Q7 shows the profiles of a component which are to be finish-machined using the DOGSNC machining simulation package, a suitable post-processor, and a CNC Vertical Machining Centre. The profiles are labelled B-1-0 to I-1-0 and any relevant dimensions are shown.

The program appended in Table Q7(i) is the start of the DOGSNC program which, when post-processed, will provide the necessary tool movements to manufacture the component.

- (i) Describe in detail the instructions that the program signifies so far. This can be done using the appended Table Q7(i) which should be handed in with your Answer Book. Table Q7(ii) gives a full listing of all the relevant DOGSNC commands.

(8 marks)

- (ii) The program contains a mistake which you should locate and rectify. The mistake is not in the syntax of the program, but is fundamental to the machining of the profile geometry.

(2 marks)

- (iii) Using Table Q7(i) again, complete the program to finish-machine the rest of the component profiles efficiently.

Note that 'area clearance' of the top and bottom faces is not required and that the holes (pattern I-1-0) do not need to be centre drilled.

(8 marks)

- (iv) Calculate the required spindle speed and cutting feedrate for one of the tools used in this program, using a surface cutting speed of 100 m/min.

(2 marks)

8. (a) Complex three-dimensional surfaces can be created by the use of a surface modelling package and the data can then be transferred to a suitable machining simulation package for tool path analysis to take place.

Explain how a prototype of this type of component could then be manufactured on a 3 axis CNC milling machine which only allows machining to take place on two axes simultaneously.

(8 marks)

- (b) In the surface milling of curved surfaces a tool with a hemispherical tip, known as a ball-ended cutter, is often used.

With the aid of diagrams, derive a formula which links the step-over between cutter paths (L) to the cusp height (h), when machining with a ball ended cutter of tip radius (R).

(8 marks)

- (c) Calculate the step-over which would be required between cutter paths to give a maximum cusp height of 1 mm using a 15 mm diameter ball-ended cutter on a plane horizontal surface.

(4 marks)

COMPANY A

INDENTED EXPLOSION OF A36

QTY: 1.0000 18/03/93 PAGE 1

Item Level	Item Code	Item Description	Item Type Unit	STOCK				
				Usage	Free	Onhand	Alloc	Due
0	A36	MAIN ASSEMBLY (No Route Details)	MA EACH	1.0000	0.0000	0.0000	0.0000	0.0000
1	B42	SUB ASSEMBLY 1 Ref:	MA EACH	1.0000	7.0000	7.0000	0.0000	0.0000
2	N02	SUB ASSEMBLY 3 Ref:	MA EACH	2.0000	15.0000	15.0000	0.0000	0.0000
3	Y67	BEARING Ref:	BI EACH	4.0000	0.0000	0.0000	0.0000	0.0000
3	Z49	SEAL Ref:	BI EACH	4.0000	30.0000	30.0000	0.0000	0.0000
?	S41	BEARING Ref:	BI EACH	1.0000	0.0000	0.0000	0.0000	0.0000
1	I16	SUB ASSEMBLY 2 Ref:	MA EACH	1.0000	15.0000	15.0000	0.0000	0.0000
2	N14	SUB ASSEMBLY 4 Ref:	MA EACH	2.0000	14.0000	14.0000	0.0000	0.0000
3	W43	BEARING Ref:	BI EACH	4.0000	0.0000	0.0000	0.0000	0.0000
3	Z49	SEAL Ref:	BI EACH	4.0000	30.0000	30.0000	0.0000	0.0000
2	Z49	SEAL Ref:	BI EACH	4.0000	30.0000	30.0000	0.0000	0.0000

Material Cost : 0.0000 Labour Cost : 0.0000 Overhead Cost : 0.0000

*** End of Report ***

Figure Q1(i)

COMPANY A

STOCK LIST

FROM A36

TO ZZZZZZZZZZZZ (BY STOCK CODE) 18/03/93 PAGE 1

----- Stock -----		Y	Del.	Bin	Units	Unit		Stock			Re-order		Supplier
		Time	No.			B.P.	S.P.	On-hand	Alloc	Due	Level	Quantity	
A36	MAIN ASSEMBLY	MA	1		EACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
A78	AXLE ASSM	MA	1		EACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
B42	SUB ASSEMBLY 1	MA	2		EACH	0.00	0.00	7.00	0.00	0.00	5.00	10.00	
C43	END CAP	BI	1		EACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
K9	CASING	BI	8		EACH	0.00	0.00	10.00	0.00	0.00	0.00	0.00	
W14	SUB ASSEMBLY 4	MA	1		EACH	0.00	0.00	14.00	0.00	0.00	10.00	10.00	
W92	SUB ASSEMBLY 3	MA	2		EACH	0.00	0.00	15.00	0.00	0.00	0.00	0.00	
P55	BEARING ASSM	MA	2		EACH	0.00	0.00	16.00	0.00	0.00	0.00	0.00	
P56	BEARING ASSM	MA	1		EACH	0.00	0.00	12.00	0.00	0.00	10.00	10.00	
3	SEAL	BI	3		EACH	0.00	0.00	30.00	0.00	0.00	10.00	25.00	
S125	BEARING	BI	2		EACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
S126	BEARING	BI	6		EACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
S41	BEARING	BI	1		EACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
T77	SHAFT	BI	4		EACH	0.00	0.00	7.00	0.00	0.00	9.00	18.00	
W43	BEARING	BI	2		EACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
I16	SUB ASSEMBLY 2	MA	2		EACH	0.00	0.00	15.00	0.00	0.00	20.00	40.00	
T67	BEARING	BI	4		EACH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Z33	SHAFT ASSM	MA	2		EACH	0.00	0.00	25.00	0.00	0.00	20.00	40.00	
Z49	SEAL	BI	3		EACH	0.00	0.00	30.00	0.00	0.00	10.00	50.00	
Z81	SHAFT ASSM	MA	2		EACH	0.00	0.00	7.00	0.00	0.00	5.00	10.00	

*** End of report ***

Figure Q1(ii)

DRAWING CONTROL DC

- 1 FULL DISPLAY
- 2 WINDOW
- 3 DRAW
- 4 CLEAR SCREEN
- 5 REDRAW
- 6 PREVIOUS WINDOW
- 7 BOUNDARY SECTIONS
- 8 DRAW OFFSET
- 9 DRAW TOOL OFFSET
- 10 CURRENT
- 11 ZOOM
- 12 PAN
- 13
- 14
- 15
- 16 TOOL POSITION
- 17 DRAW TOOL CUT -off
- 18 -on
- 19 DRAW SUBROUTINE -off
- 20 -on
- 21 DRAW TOOL -off
- 22 -current
- 23 -all
- 24 DRAW HOLDER -off
- 25 -current
- 26 -all
- 27 DRAW TURRET -off
- 28 -on
- 29 ARROW -off
- 30 -on
- 31 LOADED -current
- 32 TURRET -other
- 33 UPDATE -off
- 34 -on
- 35 DISPLAY VIEW -off
- 36 -on
- 37 CREATE VIEWPORT
- 38 MOVE VIEWPORT
- 39 PAN/ZOOM VIEWPORT
- 40 DELETE VIEWPORT

FACILITIES FA

- 1 REDRAW
- 2 RESET USER ORIGIN
- 3 REVOKE
- 4
- 5 TOLERANCE -line
- 6 -reverse
- 7
- 8
- 9
- 10
- 11
- 12 UNITS -mm
- 13 -cm
- 14 -m
- 15 -ins
- 16 -ft
- 17 PLOT -initialize
- 18 -end
- 19
- 20 DIAGNOSTICS -off
- 21 DIAGNOSTICS -on
- 22 SCREEN MENU -off
- 23
- 24
- 25
- 26
- 27
- 28
- 29 NOVICE
- 30 EXPERT
- 31
- 32
- 33
- 34
- 35
- 36
- 37
- 38
- 39
- 40 STOP

SETUP SE

- 1 SURFACE CUTTING FEED/IFPM
- 2 VERTICAL CUTTING FEED
- 3 SURFACE RAPID FEED
- 4 VERTICAL RAPID FEED
- 5 FEED PER REVOLUTION (FPR)
- 6 CONSTANT SURFACE SPEED
- 7
- 8 INCLINED PLANE
- 9 CUTTING PLANE
- 10 CLEARANCE PLANE
- 11 TOOL START POSITION
- 12 MACHINE VIEW
- 13 TURRET START POSITION
- 14 MULTIPLE TURRET LATHE
- 15 DEFINE AND LOAD TOOL
- 16 LOAD TOOL
- 17 INDEX TURRET
- 18 ROTATE TOOL
- 19 COMPENSATION NOS.
- 20 SPINDLE SPEED/GEAR RANGE
- 21 MOVE PER STROKE
- 22 STROKES PER MINUTE
- 23 WORK LIMITS
- 24 CLAMP
- 25 SHEET
- 26 SHEET LAYOUT
- 27 MACHINING ORDER
- 28 GRID SPACING
- 29
- 30
- 31 COMMENT
- 32 PART NUMBER
- 33
- 34
- 35
- 36
- 37 RELOCATE -off
- 38 CUTTER -drag
- 39 PATHS -rotate
- 40 -mirror

MEASUREME LIBRARY LI

- 1 SET DECIMAL PLACES
- 2 X,Y - REL. TO ORIGIN
- 3 L,A - REL. TO ORIGIN
- 4 X,Y - BETWEEN 2 POINTS
- 5 - BETWEEN 2 POINTS
- 6 LENGTH OF SPAN
- 7 ANGLE OF SPAN
- 8
- 9 RADIALS OF ARC
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18 IDENTIFY ITEM
- 1 INITIALIZE
- 2 SAVE ITEM /UDC
- 3 RETRIEVE ITEM /UDC
- 4 DELETE ITEM /UDC
- 5 OUTPUT
- 6 ITEM DESCRIPTION
- 7 GENERAL ENQUIRE
- 8 TOOL ENQUIRE
- 9 ACCESS ITEM
- 10 UDC MODE -off
- 11 -on
- 12 SAVE MULTIPLE UDCs

DATABASE DB

- 1 LOG ON
- 2 REPORT

MOVEMENT TYPE MT

- 1 FEED
- 2 RAPID
- 3 CLIMB
- 4 CONVENTIONAL
- 5 RAMP
- 6 CORNER LOOPING
- 7 CUTTER COMP -off
- 8 -on
- 9 -left
- 10 -right
- 11 -auto
- 12 -manual
- 13 LEAD -off
- 14 -in only
- 15 -out only
- 16 -in and out
- 17 ROLL -off
- 18 -on
- 19 BOUNDARY OPT'S -forward
- 20 -back
- 21 BOUNDARY OPT'S -int.
- 22 OFFSET LOOK AHEAD
- 23 DEF. OFFSET ALLW. -off
- 24 -on
- 25 SMOOTHNESS
- 26 AXIS 1 RE-ENTRY -off
- 27 -pos.
- 28 -neg
- 29 AXIS 2 RE-ENTRY -off
- 30 -pos.
- 31 -neg.
- 32 BOUNDARY STOP -off
- 33 -on
- 34 EXTEND BOUNDARY -off
- 35 -on
- 36 SLIDE -off
- 37 -on
- 38 POSITION
- 39 POSITION AND PUNCH
- 40 NIBBLE/FLAME

MOVEMENT MV

- 1 BOUNDARY
- 2 GOTO
- 3 INCREMENTAL GOTO
- 4 MOVE AXIS 1 ONLY
- 5 MOVE AXIS 2 ONLY
- 6 DESCEND
- 7 RETRACT
- 8 GO HOME
- 9 LINK POINTS
- 10 MOVE REL. TO BOUNDARY
- 11 MOVE REL. TO LINE
- 12 MOVE AXIS 1 & 2 ONLY.
- 13 CORNER CUT
- 14 AREA/STOCK CLEARANCE
- 15
- 16
- 17 ROTATE AXIS -1
- 18 -2
- 19 -3
- 20
- 21 SLOT
- 22 PUNCH BOUNDARY
- 23
- 24 MOVE AXIS 3 ONLY

NC UTILITIES NC

- 1 MILL
- 2 LATHE
- 3 NIBBLE
- 4 FLAME CUT
- 5 GRINDING
- 6 ORDER SEQUENCES
- 7 NEW SEQUENCE
- 8 RETRIEVE SEQUENCE
- 9 COPY SEQUENCE
- 10 FILE SEQUENCE
- 11 QUIT SEQUENCE
- 12 DOGS INPUT
- 13 RETR. WORKING -readable
- 14 STORE -coded
- 15 RETRIEVE TAPE SKELETON
- 16 QUIT TAPE SKELETON
- 17
- 18 TOOL STATUS
- 19 DISPLAY STATUS
- 20 OUTPUT STATUS -off
- 21 OUTPUT STATUS -on
- 22 OUTPUT COMMANDS -off
- 23 -on
- 24 LIST WORKING STORE
- 25 DELETE FROM STORE
- 26
- 27
- 28 MACRO UDC
- 29 RETRIEVE UDC
- 30 EDITOR
- 31 EXTERNAL PROGRAM
- 32 CLDATA -off
- 33 -on
- 34 WRITE CLDATA
- 35 FULL LISTING -off
- 36 -on
- 37 READABLE CLDATA -off
- 38 -on
- 39 QUIT
- 40 FINISH

SEQ. EDIT ED CYCLES CY

- 1 LOCATE
- 2 NEXT
- 3 BACK
- 4 GOTO LINE N
- 5 RESTART
- 6 CHANGE
- 7 DELETE
- 8 DELETE N LINES
- 9 CURRENT LINE NUMBER
- 10 REPEAT CURRENT LINE
- 11 COPY LINE(S)
- 12
- 13
- 14
- 15 LINE NOS. -off
- 16 -on
- 17 SEQ GRAPHICS -off
- 18 -on
- 19 EXECUTE -off
- 20 -on
- 1 DRILL
- 2 DEEP DRILL
- 3 BREAK CHIP
- 4 TAP
- 5 BORE 1
- 6 BORE 2
- 7 BORE 3
- 8 BORE 4
- 9 BORE 5
- 10 THREAD
- 11
- 12
- 13
- 14
- 15
- 16
- 17 CYCLE SET 1
- 18 CYCLE SET 2
- 19 DEFINE PATTERN -off
- 20 -on

PREP. FUNCTIONS P

- 1 STOP
- 2 DELAY
- 3 COOLANT -off
- 4 -on
- 5 -on flood
- 6 -on mist
- 7 INSERT
- 8 OSKIP -off
- 9 -on
- 10 ARC TOLERANCE
- 11 PP COMMANDS
- 12 INCREMENTAL
- 13 ABSOLUTE
- 14 SWOP AXIS
- 15 SAFE START
- 16 REPEAT COMMANDS
- 17 SUBROUTINE -start
- 18 -end
- 19 -call
- 20 PLANE -XY
- 21 PLANE -ZX
- 22 -YZ
- 23
- 24
- 25 RAISE HEADS
- 26 LOWER HEADS
- 27 LOCK HEADS -off
- 28 LOCK HEADS -on
- 29
- 30
- 31
- 32
- 33
- 34
- 35
- 36
- 37 BEGIN FOR SHEE
- 38 REPEAT FOR SH
- 39 BEGIN FOR ROW
- 40 REPEAT FOR RO

ELEVATION SELECT ES

- 1 ONE ELEVATION
- 2 TWO ELEVATIONS
- 3 THREE ELEVATIONS
- 4 FOUR ELEVATIONS
- 5 FIRST ANGLE PROJECTION
- 6 THIRD ANGLE PROJECTION
- 7 PREVIOUS LAYOUT
- 8 DEFAULT LAYOUT
- 9 DEFINE DEFAULT LAYOUT
- 10 PERSPECTIVE
- 11 PARALLEL PROJECTION
- 12 ISOMETRIC
- 13 SET VERTICAL AXIS
- 14 ROVING EYEPOINT
- 15 FIXED EYEPOINT
- 16 DISPLAY WINDOW BOX -off
- 17 -on
- 18 DISPLAY AXES -off
- 19 -on

BOUNDARY MAN. BM

- 1 ORDER POINTS
- 2 OFFSET
- 3 REVERSE
- 4 DRAG
- 5 ROTATE
- 6 MIRROR
- 7 COPY DRAG
- 8 COPY ROTATE
- 9 COPY MIRROR
- 10 DEFINE NAMED GROUP
- 11 DEFINE PATTERN
- 12 DEFINE PLANE
- 13 SET BOUNDARY DEPTH
- 14 CREATE MACHINE VIEW

TOOL/FIXTURE DEFN

- 1 MILLING TOOL
- 2 LATHE TURRET
- 3 LATHE HOLDER
- 4 LATHE TOOL
- 5 LATHE LOADED TURRET
- 6 CONTINUE
- 7 NIBBLING TOOL
- 8 FLAME CUT TOOL
- 9 MULTIPLE TURRET
- 10
- 11 DEFINE WORK L
- 12 DEFINE CLAMP
- 13 DEFINE SHEET

ACCEPT AC TYPED INPUT HELP

Table Q7(ii)