

SURNAME: DAVIES

FORENAME(S): MATTHEW

12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

1	Student Number	1909365
2	Title of Examination Paper	ELECTRONIC PRODUCTION & TEST
3	Module Code	SGEE 6002
4	Date and Time of Examination	19/5/23 09:30
5	Examination Venue	COLLEGE SIR GAR GRAIG
6	Seat Number	33.
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
Q1	8
Q2	24
Q3.	16
Total	48%

(Gweler yr ochr arall am y fersiwn Cymraeg)

MARK
AGREED
48%



Prifysgol Cymru
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Llyfr Atebion Arholiadau

Cyfarwyddiadau i Ymgeiswyr

12 Tudalen

CYFENN:

ENW(AU) CYNTAF:

Llenwch, plygwch a seliwch
(gweler nodyn 2 isod)

1. Rhwch yr holl wybodaeth y gofynnir amdani yn y blychau isod.
2. Rhwch eich enw yn y lle a ddarparwyd ar y dde, plynwch ef a'i selio i lawr (gan ddefnyddio'r label a ddarparwyd) i guddio'ch enw.

3. Rhaid i'r atebion fod mewn llawysgrifen dda. gael ei theipio a chael yr ymgeisydd i dalu.

4. Ysgriennwch eich atebion mewn inc.

5. Dechreuwch bob ateb ar dudalen newydd. Gwnewch unrhyw ffras nodiadau yn y llyfr atebion a thynnu llinell drwyddynt.

6. Ni ddylid rhwgo unrhyw ran o'r llyfr hwn; rhaid ei gyflwyno yn gyfan.

7. Os defnyddir mwy nag un llyfr, rhwymwch hwy gyda'i gilydd gan ddefnyddio'r tagiau sydd ar gael oddi wrth y gwyllywr/gwylwyr.

8. Rhaid dychwelyd pob llyfr. Ni chaniateir mynd â llyfrau atebion, wedi eu defnyddio neu heb eu defnyddio, allan o'r lleoliad arholi o dan unrhyw amgylchiadau.

1	Rhif Myfyriwr	
2	Teitl y Papur Arholiad	
3	Cod y Modwl	
4	Dyddiad ac Amser yr Arholiad	
5	Lleoliad yr Arholiad	
6	Rhif Sedd	
7	Nifer y Llyfrau Atebion a gyflwynwyd	

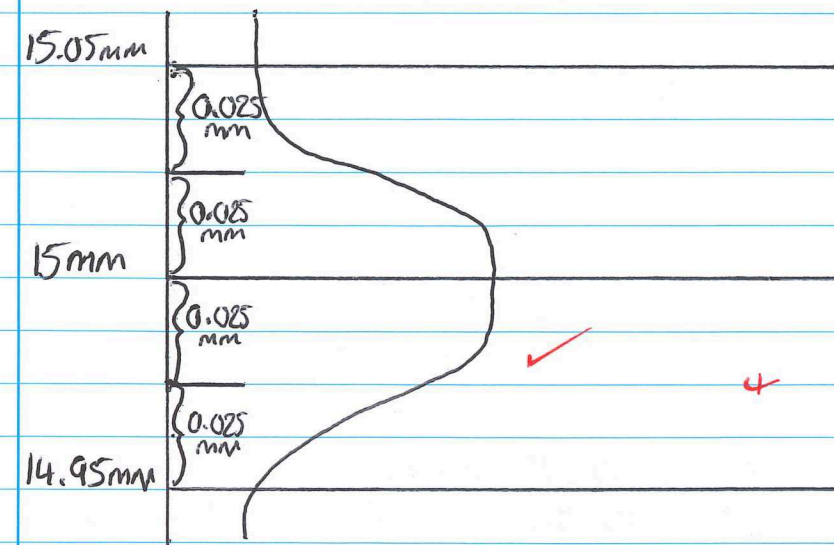
(See the other side for English version)

[illegible]

2a. i) $STD = Range/\sigma$

$$STD = 0.05/2$$

$$STD = 0.025 \quad \checkmark \quad 2$$



ii) $C_p = (Upper\ Spec - Lower\ Spec) / 6\sigma$

$$C_p = (15.05 - 14.95) / (6 \times 0.025) \quad \checkmark$$

$$C_p = 0.1 / 0.15$$

$$C_p = 0.6 \quad \checkmark \quad 3$$

Therefore it is 'not capable' as $C_p < 1$ $\checkmark$

3 sigma:

$$STD = 0.05/3$$

$$STD = 0.016 \quad \checkmark$$

$$C_p = (15.05 - 14.95) / (6 \times 0.016) \quad \checkmark$$

$$C_p = 1.04 \quad \checkmark \quad 3$$

The system would be 'capable' at 3 sigma as $C_p > 1$ just about. Although, it would be recommended to increase the sigma level to improve the C_p value. $\checkmark$

iii) Six Sigma is a process quality goal, where sigma is a statistical value which determines the capability of a system depending on its range and standard deviations.

For a process to be 'capable', a six sigma ruler must fit onto a chart at least once for the system to be considered capable. This is determined by the C_p value.

b) i) $STD = Range / \sigma$ mean = 15.02
 $STD = 0.05 / 4$ Range = ± 0.05
 $STD = 0.0125$

Upper limits - 15.0125, 15.025, 15.0375, 15.05
 Lower limits - 14.9875, 14.975, 14.9625, 14.95

ii) $C_{pk} = \min (Mean - L_{spec} / 3\sigma, U_{spec} - mean / 3\sigma)$
 $C_{pk} = \min (1.86, 0.8)$
 $C_{pk} = 0.8$

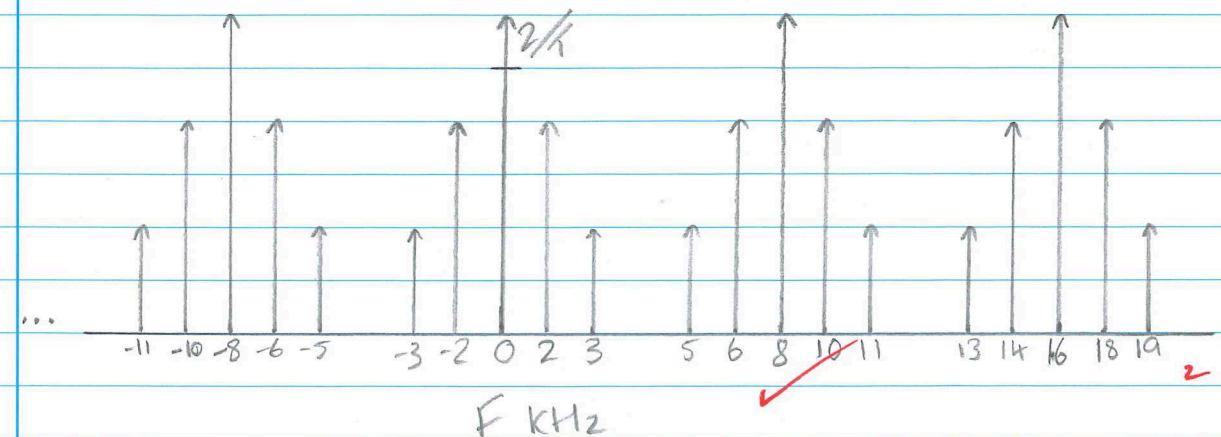
iii) This indicates that the machine would be 'not capable' due to the shift in the mean causing the C_{pk} value to fall below 1 to 0.8 for one side. For the system to be determined 'capable', it would require both figures to be > 1 .

iv). The C_p value wouldn't be suitable to take this into consideration as the C_p calculation doesn't take into account the change in the mean, whereas the C_{pk} value takes the mean into account.

3.a) Sample rate of 8000Hz given by:

$$x(t) = 4 \cos(2\pi * 2000t) + 2 \cos(2\pi * 3000t) \text{ for } t \geq 0.$$

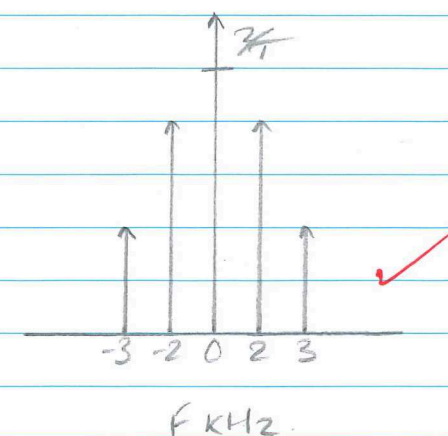
i)



Using Euler's Identity:

$$x(t) = \frac{2}{2} e^{-j2\pi * 3000t} + \frac{4}{2} e^{-j2\pi * 2000t} + \frac{2}{2} e^{j2\pi * 3000t} + \frac{4}{2} e^{j2\pi * 2000t}$$

ii)



c) Bandpass FIR filter with 5 Taps and sample rate of 8000Hz.

$$i) \Omega_L = \frac{2\pi f_L}{f_s} = \frac{2\pi \times 2000}{8000} = 0.5\pi \text{ [rads]} \quad \checkmark$$

$$\Omega_H = \frac{2\pi f_H}{f_s} = \frac{2\pi \times 2400}{8000} = 0.6\pi \text{ [rads]}. \quad \checkmark$$

Taps $\rightarrow$ filter length.

$$5 \text{ Taps} = 2M + 1 \quad \therefore M = 2. \quad \checkmark$$

$$h(n) = \begin{cases} \frac{\Omega_H - \Omega_L}{\pi} & \text{for } n=0 \\ \frac{\sin(\Omega_H n)}{n\pi} - \frac{\sin(\Omega_L n)}{n\pi} & \text{for } n \neq 0, -M \leq n \leq M \\ & -2 \leq n \leq 2 \end{cases} \quad \checkmark$$

$$h(0) = \frac{\Omega_H - \Omega_L}{\pi}$$

$$h(0) = \frac{0.6\pi - 0.5\pi}{\pi}$$

$$h(0) = 0.1 \quad \checkmark$$

$$h(1) = \frac{\sin(0.6\pi \times 1)}{1 \times \pi} - \frac{\sin(0.5\pi \times 1)}{1 \times \pi}$$

$$h(1) = -0.01558 \quad \checkmark$$

$$h(2) = \frac{\sin(0.6\pi \times 2)}{2 \times \pi} - \frac{\sin(0.5\pi \times 2)}{2 \times \pi}$$

$$h(2) = -0.09355 \quad \checkmark$$

Applying Symmetry:

$$h(-1) = h(1) = -0.01558 \quad \checkmark$$

$$h(-2) = h(2) = -0.09355 \quad \checkmark$$

$$h(0) = 0.1 \quad \checkmark$$

$$ii) \begin{matrix} h(-2) & h(-1) & h(0) & h(1) & h(2) & \checkmark \\ b_0 & b_1 & b_2 & b_3 & b_4 & \checkmark \end{matrix}$$

$$b_0 = h(0-2) = -2 \quad \leftarrow \text{Applying a delay of } M=2.$$

$$b_1 = h(1-2) = -1$$

$$b_2 = h(2-2) = 0.$$

$$b_3 = h(3-2) = 1$$

$$b_4 = h(4-2) = 2.$$

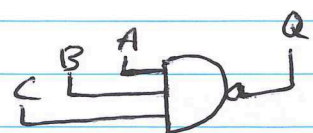
Transfer function:

$$H(z) = b_0 + b_1 z^{-1} + b_2 z^{-2} + b_3 z^{-3} + b_4 z^{-4} \quad \checkmark$$

$$H(z) = -0.09355 - 0.01558 z^{-1} + 0.1 z^{-2} - 0.01558 z^{-3} - 0.09355 z^{-4} \quad \checkmark$$

1. a) 'Single stuck at' fault models are a simple way of testing a digital electronic circuit for how the output of a circuit could potentially change state depending on one of its inputs either being stuck @ 1 or stuck @ 0. ✓
Test vectors are created for these tests and these can be implemented on an Auto Testing system such as multisim so that the results can be recorded digitally and it's relatively easy to use. ✓ 3

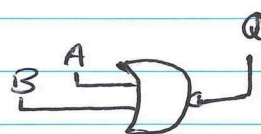
b) 3 Input NAND:



Test No.	A	B	C	Q
1	1	1	1	0
2	0	1	1	1
3	1	0	1	1
4	1	1	0	1

Number of tests = No. of inputs (n) + 1.

2 input NOR:



Test No.	A	B	Q
1	0	0	1
2	1	0	0
3	0	1	0

The 3 input NAND gate provides an output of logic 1 when any 1 of its inputs is set to logic 0, so a 'Single stuck at' fault of 0 on any of its 3 inputs would cause the output Q to stay stuck @ 1.

The 2 input NOR gate requires 2 logic 0 inputs to provide a logic 1 output on node Q, therefore if either input A or B

were stuck @ logic 1, then it would cause the output to be stuck @ logic 0.

PRESENT STATE						NEXT STATE					
A	B	C	D	E	F	A ⁺	B ⁺	C ⁺	D ⁺	E ⁺	F ⁺
1	1	1	0	0	0	1	1	1	1	1	1
0	1	1	0	0	0	1	1	1	0	0	0
1	0	1	0	0	0	0	1	1	0	0	0
1	1	0	0	0	0	1	0	1	0	0	0
0*	0*	0	1	0	0	1	1	0	0	0	0
0*	0*	0	0	1	0	0	0	0	1	0	0
1	1	1	1	1	0	0	0	0	0	1	0
1	1	1	1	1	1	1	1	1	1	1	0

ABC	000	010	001	011	100	110	101	111
DEF	0	0	0	1	0	1	0	1
000	0	0	0	0	0	0	0	0
010	0	0	0	0	0	0	0	0
001	0	0	0	0	0	0	0	0
000	0	0	0	0	0	0	0	0
100	1	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	1

$$A^+ = DA = NA.B.C.ND.NE.NF + A.B.NC.ND.NE.NF + A.B.C.ND.NE.NF + NA.NB.NC.D.NE.NF + A.B.C.D.E.F.$$

ABC	000	010	001	011	100	110	101	111
DEF	0	0	0	1	0	0	1	1
000	0	0	0	0	0	0	0	0
010	0	0	0	0	0	0	0	0
001	0	0	0	0	0	0	0	0
011	0	0	0	0	0	0	0	0
100	1	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	1

$$B^+ = DB = NA.B.C.ND.NE.NF + NA.A.C.ND.NE.NF + NA.NB.NC.D.NE.NF + A.B.C.D.E.F.$$

ABC DEF	000	010	001	011	100	110	101	111
000	0	0	0	1	0	0	1	1
010	0	0	0	0	0	0	0	0
001	0	0	0	0	0	0	0	0
011	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	1

X

$C^+ = DC = NA.B.C.ND.NE.NF + A.ND.NE.NF + A.B.C.D.E.F$

ABC DEF	000	010	001	011	100	110	101	111
000	0	0	0	0	0	0	0	1
010	1	0	0	0	0	0	0	0
001	0	0	0	0	0	0	0	0
011	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	1

X

$D^+ = DD = A.B.C + NA.NB.NC.ND.E.NF$

ABC DEF	000	010	001	011	100	110	101	111
000	0	0	0	0	0	0	0	1
010	0	0	0	0	0	0	0	0
001	0	0	0	0	0	0	0	0
011	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	1
101	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	1

X

$E^+ = DE = A.B.C + A.B.C.D.E.NF$

ABC DEF	000	010	001	011	100	110	101	111
000	0	0	0	0	0	0	0	1
010	0	0	0	0	0	0	0	0
001	0	0	0	0	0	0	0	0
011	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0
101	0	0	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0

X

$F^+ = OF = A.B.C.ND.NE.NF$