



## 12 Pages

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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.
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6. No part of this book is to be torn out; it must be handed in complete.
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|   |                                  |                       |
|---|----------------------------------|-----------------------|
| 1 | Student Number                   | 2017197               |
| 2 | Title of Examination Paper       | ELECTRONICS 2         |
| 3 | Module Code                      | SGEE5000              |
| 4 | Date and Time of Examination     | 10/5/22<br>9.30-12.00 |
| 5 | Examination Venue                | GYM                   |
| 6 | Seat Number                      | 14                    |
| 7 | Number of Answer Books handed in | 1                     |

[illegible]

78%

A1)  ~~$20 \log 90 = 39.1$~~   $\text{ant. log}^{90/20} = 31622$  ✓

ii)  ~~$10 \log 35 = 15.4$~~   $\text{ant. log}^{35/10} = 3162$  ✓

A2)  $250 \Omega$   $36 \text{ dB}$   $5 \text{ mV}$

$5 \text{ mV} \times 250 = 1.25 \text{ V}$

$\text{ant. log}^{36/20} = 63.1$  ✓  
 $\times 5 \text{ mV}$

~~$1.956$~~

~~$2 \times \text{ant. log}^{90/20}$~~

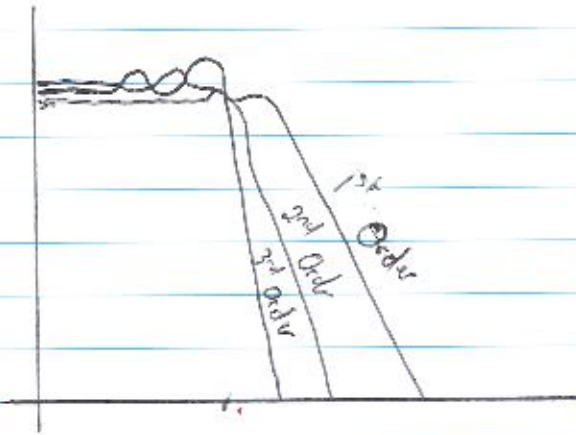
ii)  ~~$\sqrt{250 \times 1.25} = 17.71 \text{ V}$~~   $\sqrt{250 \times 63.1} = 125.6 \text{ V}$  ✗

A3)  $A_{VF} = \frac{A_V}{1 + A_V M_V} = \frac{500}{1 + (500 \times 0.015)}$   
 $= 58.8$  ✓

A5)  $F = \frac{1}{2\pi\sqrt{LC}} \therefore C = \frac{1}{L \times (2\pi \times F)^2} = \frac{1}{4\mu \times (2\pi \times 20\text{M})^2}$   
 $= 1.58 \times 10^{-11}$   
 $= 15.8 \text{ pF}$  ✓

A6) A Colpitts oscillator has two capacitors in parallel with one inductor. The two capacitors are centre-tapped. The two capacitors charge up fully, before discharging through the inductor, which causes the oscillations.

A8) A Tchebyscheff filter type has the sharpest roll-off of any of the filters, but the filter has an unstable pass-band range that is not as flat as the Bessel and Butterworth filters.



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A9)  $Q = 105$        $F_0 = 2.1 \text{ MHz}$   
 $BW = F_0 / Q = 2.1 \text{ M} / 105$

$BW = 20 \text{ K}$  ✓

Cut-off - =  $2.08 \text{ MHz}$     2.09

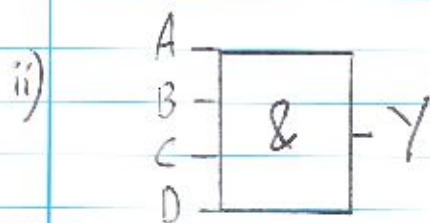
Cut-off + =  $2.12 \text{ MHz}$     2.11

2

$\% = \frac{1}{2} \Delta \omega$

A10) Inputs = A, B, C, D

Outputs = Y



iii) Gate 1 is a 4input AND gate.

4

$$B2) R_1 = \frac{a_1}{2\pi f_c C_1} = \frac{0.6656}{2\pi \times 75k \times 470p}$$

$$= 3005 \Omega \quad \checkmark$$

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ii) Stage 2 and 3 C values

$$C_2 > \frac{C_1 \times 4b}{a^2} = \frac{470p \times 4 \times 0.4128}{1.1402^2}$$

$$= 5.97 \times 10^{-10} \text{ or } 597pF$$

Use 600pF for Stage 2

4

$$C_2 > \frac{C_1' \times 4b}{a^2} = \frac{470p \times 4 \times 0.3245}{0.6216^2}$$

$$= 1.59 \times 10^{-9} \text{ or } 1.59nF$$

Use 1.6nF for Stage 3

2

$$iii) R_{2,3} = \frac{a_1 C_2 \pm \sqrt{a_1^2 C_2^2 - 4b_1 C_1 C_2}}{4\pi f_c C_1 C_2}$$

$$= \frac{1.1402 \times 600p \pm \sqrt{(1.1402 \times 600p)^2 - 4 \times 0.4128 \times 600p \times 470p}}{4\pi \times 75k \times 470p \times 600p}$$

$$R_2 = 2390 \Omega \quad \checkmark$$

$$R_3 = 2758 \Omega \quad \checkmark$$

6

$$R_{4,5} = \frac{0.6216 \times 1.6n \pm \sqrt{(0.6216 \times 1.6n)^2 - 4 \times 0.3245 \times 470p \times 1.6n}}{4\pi \times 75k \times 470p \times 1.6n}$$

$$R_4 = 1242 \Omega \quad \checkmark$$

$$R_5 = 1564 \Omega \quad \checkmark$$

4

B2b)  $m_v = 0.2$      $C = 2.2 \text{ pF}$      $F = 5 \text{ MHz}$

$$m_v = \frac{L_2}{L_1} \quad 0.2 = \frac{L_2}{L_1} \quad L_1 = 5L_2$$

$$F = \frac{1}{2\pi\sqrt{L_1 C}} \quad \therefore L_T = \frac{1}{C \times (2\pi \times F)^2}$$

$$= \frac{1}{2.2 \times (2\pi \times 5)^2}$$

$$= 4.6 \times 10^{-4} \text{ or } 0.46 \text{ mH}$$

4

$$L_T = \frac{L_1 + L_2}{L_1 \times L_2} \quad \div \text{ by } L_2 \quad = \frac{5 + 1}{L_1} = \frac{6}{L_1}$$

$$L_T = \frac{6}{L_1} \quad 0.46 \text{ m} = \frac{6}{L_1} \quad L_1 = \frac{6}{0.46 \text{ m}} = 0.00076$$

$$L_1 = \frac{0.46 \text{ m}}{6} = 0.000076 \text{ or } 76 \mu\text{H}$$

2

$$\therefore L_2 = 0.2 \times L_1 \quad L_2 = 0.2 \times 76 \mu\text{H}$$

$$= 15 \mu\text{H}$$

x5.

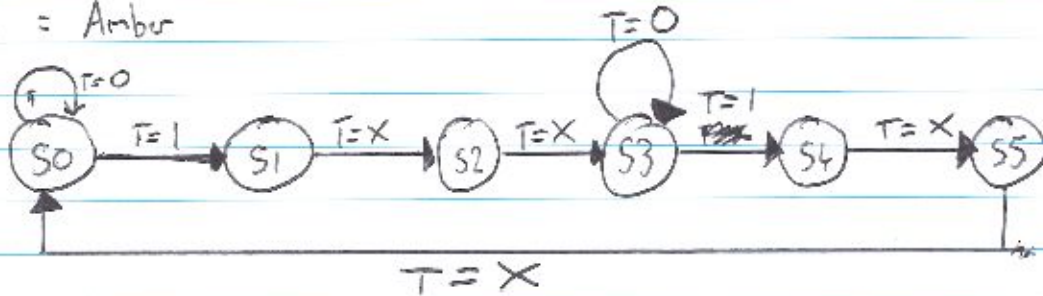
B2 c)  $68 \text{ pF}$      $f = 500 \text{ kHz}$

$$68 \text{ p} \times 500 \text{ k} = 34 \times 10^{-5}$$

$$= 34 \mu\Omega$$

x

B3a)  $S_0 = \text{Red}$   
 $S_1 = \text{Red/Amber}$   
 $S_2 = \text{Red/Amber}$   
 $S_3 = \text{Green}$   
 $S_4 = \text{Amber}$   
 $S_5 = \text{Amber}$



| State | Next State |       | $T=0$ |       |       | $T=1$ |       |       | Outputs |   |   |
|-------|------------|-------|-------|-------|-------|-------|-------|-------|---------|---|---|
|       | $T=0$      | $T=1$ | $Q_A$ | $Q_B$ | $Q_C$ | $Q_A$ | $Q_B$ | $Q_C$ | R       | A | G |
| S0    | S0         | S1    | 0     | 0     | 0     | 0     | 0     | 1     | 1       | 0 | 0 |
| S1    | S2         | S2    | 0     | 1     | 0     | 0     | 1     | 0     | 1       | 1 | 0 |
| S2    | S3         | S3    | 0     | 1     | 1     | 0     | 1     | 1     | 1       | 1 | 0 |
| S3    | S3         | S4    | 0     | 1     | 1     | 1     | 0     | 0     | 0       | 0 | 1 |
| S4    | S5         | S5    | 1     | 0     | 1     | 1     | 0     | 1     | 0       | 1 | 0 |
| S5    | S0         | S0    | 0     | 0     | 0     | 0     | 0     | 0     | 0       | 1 | 0 |

| $Q_A$<br>TA | BC | 00 | 01 | 11 | 10 |
|-------------|----|----|----|----|----|
| 00          |    | 0  | 0  | 0  | 0  |
| 01          |    | 1  | 0  | X  | X  |
| 11          |    | 1  | 0  | X  | X  |
| 10          |    | 0  | 0  | X  | 0  |

$$Q_A^+ = A\bar{C} + TBC$$

| $Q_B$<br>TA | BC | 00 | 01 | 11 | 10 |
|-------------|----|----|----|----|----|
| 00          |    | 0  | 1  | 1  | 1  |
| 01          |    | 0  | 0  | X  | X  |
| 11          |    | 0  | 0  | X  | X  |
| 10          |    | 0  | 1  | 0  | 1  |

$$Q_B^+ = \bar{A}\bar{B}C + \bar{T}B + B\bar{C}$$

| $Q_C$<br>TA | BC | 00 | 01 | 11 | 10 |
|-------------|----|----|----|----|----|
| 00          |    | 0  | 0  | 1  | 1  |
| 01          |    | 1  | 0  | X  | X  |
| 11          |    | 1  | 0  | X  | X  |
| 10          |    | 1  | 0  | 0  | X  |

$$Q_C^+ = A\bar{C} + T\bar{C} + \bar{T}B$$

B3a)

| $R_{QA}$ | $QBQC$ | 00 | 01 | 11 | 10 |
|----------|--------|----|----|----|----|
| 0        |        | 1  | 1  | 0  | 1  |
| 1        |        | 0  | 0  | X  | X  |

$R = \overline{QA} \overline{QB} + QB \overline{QC}$

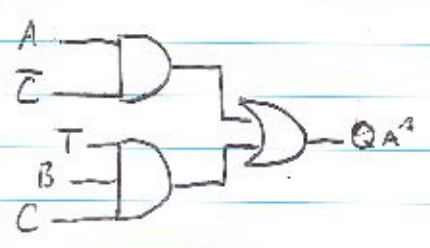
| $A_{QA}$ | $QBQC$ | 00 | 01 | 11 | 10 |
|----------|--------|----|----|----|----|
| 0        |        | 0  | 1  | 0  | 1  |
| 1        |        | 1  | 1  | X  | X  |

$A = QA + \overline{QB} QC + QB \overline{QC}$

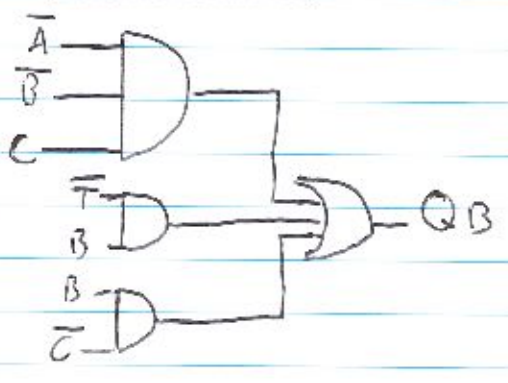
| $G_{QA}$ | $QBQC$ | 00 | 01 | 11 | 10 |
|----------|--------|----|----|----|----|
| 0        |        | 0  | 0  | 1  | 0  |
| 1        |        | 0  | 0  | X  | X  |

$G = QBQC$

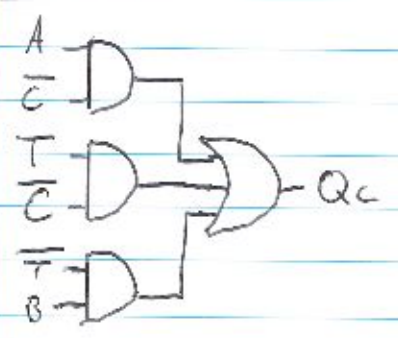
QA Circuit



QB Circuit

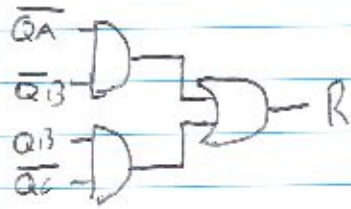
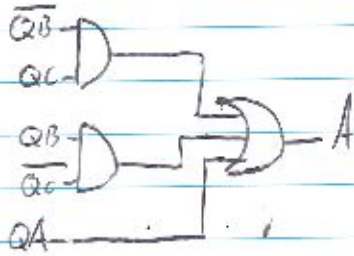


QC Circuit



Red Circuit

B3a)

Amber CircuitGreen Circuit

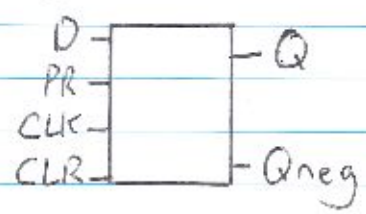


B3b)

i) Inputs = D, PR, CLK, ~~CLR~~ ✓

Outputs = Q, Qneg ✓

ii) Entity



iii) Gate 1 is a D-type Flip-flop with inputs PR and CLR added to it.

When D is hi, Q will go hi on the next CLK pulse, while when D goes lo, Q will remain hi unt. the next CLK pulse. Q neg is hi, when Q is lo.

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