

EXAMINATION INTERNAL VERIFICATION FORM (2017-2018)

MODULE :	PSDE 5006 – Electronics II			LEVEL:	5
PROGRAMME :	HNC Electrical and Electronic Engineering			TERM OF EXAM: (SPRING OR SUMMER)	Summer
LEARNING OUTCOME(S) BEING ASSESSED:	All	EXAM PAPER:	Main	EXAMINATION AUTHOR :	M Hall

VERSION:	DATE SUBMITTED FOR VERIFICATION:	INTERNAL VERIFIER COMMENTS (Approval or detail of amendments required):	DATE:
1.	24/01/2018	This exam complies with the module content and is fit for purpose.	27/03/2018
2.			

INTERNAL VERIFIER PLEASE TICK TO INDICATE THAT THE EXAMINATION:	
✓	Conforms to the assessment pattern described in the module syllabus
✓	Tests the module learning outcome(s) appropriately

SIGNATURES OF FINAL APPROVAL:	SIGNATURE	DATE
INTERNAL VERIFIER: I confirm that this version of the exam paper is ready to be sent to the external examiner		27/03/2018
EXAM AUTHOR: I confirm that internal verifier and external examiner approval have been received and that this version of the exam paper is ready for printing.		

LOCATION: COLEG SIR GAR

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LEVEL 5

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EXAMINATION PERIOD

MAY 2018

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MAI 2018

MODULE CODE: PSDE 5006

Electronics II

TIME: 2 HOURS

THIS PAPER IS IN 2 PARTS:

ANSWER ALL QUESTIONS IN PART A

ANSWER TWO QUESTIONS OUT OF THREE IN PART B

Equipment or materials required – Calculator

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MAIN

Formulae

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$m_v = \frac{C_1}{C_2}$$

$$m_v = \frac{L_2}{L_1}$$

$$f_0 = \frac{1}{2\pi CR \sqrt{6}}$$

$$BW = \frac{f_0}{Q}$$

$$R_1 = \frac{a_1}{2\pi f_c C_1}$$

$$C_2 > \frac{C_1 \times 4b}{a^2}$$

$$R_1 = \frac{1}{2\pi f_c a_1 c_1}$$

$$R_1, R_2 = \frac{a_i C_2 \pm \sqrt{a_i^2 C_2^2 - 4b_i C_1 C_2}}{4\pi f_c C_1 C_2}$$

$$R_1 = \frac{1}{\pi f_c \times C \times a_2} \quad , \quad R_2 = \frac{a_2}{4\pi f_c \times C \times b_2}$$

PART A – Answer ALL questions.

A1. Find the gain in dB in the following cases:

- a. Voltage gain of 750
- b. Power gain of 2000

(4 marks)

A2. An amplifier rated at 40W output is connected to a 8Ω speaker. Calculate the input power required for full power output if the power gain is 50dB.

(3 marks)

A3. The overall gain of a multistage amplifier is 1000. When negative voltage feedback is applied, the gain is reduced to 50. Find the fraction of the output that is fed back to the input.

(3 marks)

A4. Explain the principle of operation of the Colpitts oscillator.

(5 marks)

A5. Describe with the aid of a diagram the equivalent circuit of a quartz crystal.

(4 marks)

A6. Find the capacitance of the capacitor required to build an LC oscillator that uses an inductance of $L = 1.5\mu\text{H}$ to produce a sine wave of frequency 200MHz.

(3 marks)

A7. A tuned amplifier has maximum voltage gain at a frequency of 5MHz and the bandwidth is 75kHz. Find the Q factor.

(3 marks)

A8. Determine the component values required for an active 2nd order unity gain high pass Bessel filter with a 3dB cut-off frequency of 120kHz. A capacitor of 1nF is available and an extract from the Bessel co-efficients table is given below.

n	i	a_i	b_i	$k_i = f_{Ci} / f_C$	Q_i
1	1	1.0000	0.0000	1.000	—
2	1	1.3617	0.6180	1.000	0.58
3	1	0.7560	0.0000	1.323	—
	2	0.9996	0.4772	1.414	0.69

(6 marks)

A9. Explain the main features of the Butterworth filter types. Illustrate your answer with appropriate bode plots.

(5 marks)

A10. The VHDL code for a standard logic gate is shown below.

- i. What are the inputs and outputs for Gate1?
- ii. Draw the entity for Gate1.
- iii. Explain the operation of Gate1 with the aid of a truth table.

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;

entity Gate1 is
    port (
        A: in STD_LOGIC;
        B: in STD_LOGIC;
        C: in STD_LOGIC;
        D: in STD_LOGIC;
        Y : out STD_LOGIC
    );
end Gate1;

architecture BEHAVIORAL of Gate1 is

begin
    Y <= A and B and C and D;
end BEHAVIORAL;
```

(4 marks)

Total Marks for Part A = 40

PART B – Only answer 2 of the following 3 questions (B1, B2, B3)

If you answer all 3, only B1 and B2 will be marked

B1 – Special Amplifiers

- a. A three-stage amplifier has a first stage voltage gain of 350, second stage voltage gain of 100 and third stage voltage gain of 175. Find the gain of each stage and the total voltage gain in dB. (4 marks)
- b. An amplifier feeding a resistive load of 2k has a voltage gain of 75dB. If the input signal is 1.5mV, find:
i. The output voltage
ii. The load power (4 marks)
- c. Figure B1.1 shows a direct coupled two-stage amplifier. Determine the DC voltages for both stages if V_{CC} is 15V.

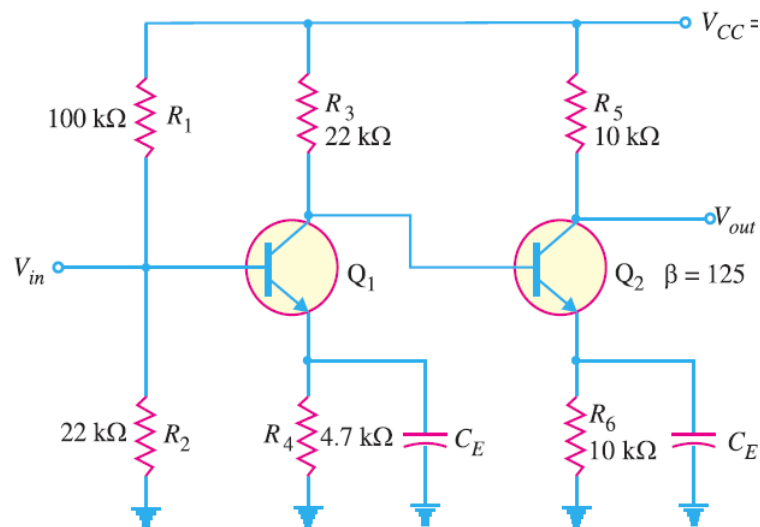


Figure B1.1

- d. The voltage gain of an amplifier without feedback is 2200. Calculate the voltage gain of the amplifier if negative voltage feedback is introduced in the circuit. Given that the feedback fraction $m_v = 0.015$. (3 marks)

- e. Compare the 3 types of coupling; RC, transformer and direct in terms of frequency response, cost, impedance matching and use. (4 marks)
- f. For the tuned amplifier shown in Figure B1.2, determine the resonant frequency, the Q of tank circuit and the bandwidth of the amplifier for the following component values:

$$C = 0.22\mu\text{F}, L = 35\text{mH}.$$

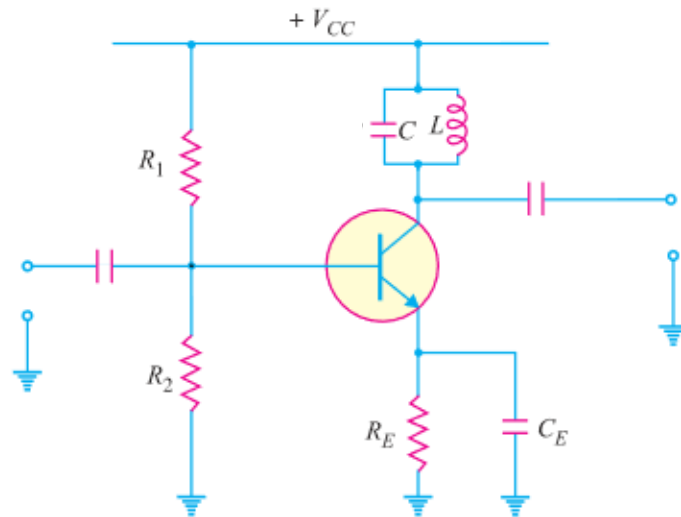


Figure B1.2

- (3 marks)
- g. The Q of a tuned amplifier is 120. If the resonant frequency for the amplifier is 3MHz, find the bandwidth and the cut-off frequencies. (4 marks)

Total Marks for Question B1 = 30

Question B2 – Filter and Oscillator Design

- a. The general formula for calculating the resistor values in a low pass filter is:

$$R = \frac{a_i C_2 \pm \sqrt{a_i^2 C_2^2 - 4b_i C_1 C_2}}{4\pi f_c C_1 C_2}$$

Using a 330pF capacitor for each stage, design a 5th order unity-gain Butterworth low pass filter with corner frequency (f_c) of 50kHz.

n	i	a _i	b _i
1	1	1.0000	0.0000
2	1	1.0650	1.9305
3	1	3.3496	0.0000
	2	0.3559	1.1923
4	1	2.1853	5.5339
	2	0.1964	1.2009
5	1	5.6334	0.0000
	2	0.7620	2.6530
	3	0.1172	1.0686
6	1	3.2721	11.6773
	2	0.4077	1.9873
	3	0.0815	1.0861

(20 marks)

- b. A 3mH inductor is available. Calculate the capacitor value required for a Colpitts oscillator so that the frequency of oscillation is 2.2MHz. Take m_v to be 0.2.

(10 marks)

Total Marks for Question B2 = 30

Question B3 – Finite State Machines and VHDL

- a. Using the Moore machine model, design a traffic light controller. The circuit will have 1 input (Trigger), 3 outputs (red, amber, green) and should behave as follows:

Sequence is:

- Red
- Red/amber
- Green
- Amber
- Red

The circuit should wait when at red or green until the 'Trigger' input goes high. On red/amber and amber it should automatically progress to the next state on the next clock (no waiting).

- i. Allocate the states and draw a state transition diagram
- ii. Compile a state transition table
- iii. Derive simplified expressions for the next state logic Q_A^+ , Q_B^+ and the 3 outputs.
- iv. Draw the circuit

(25 marks)

- b. The VHDL code for a standard logic gate is shown below.

- i. What are the inputs and outputs for Gate2?
- ii. Draw the entity for Gate2'.
- iii. Explain the operation of Gate2 with the aid of a truth table.

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;
entity Gate2 is
    Port ( D : in  STD_LOGIC;
          CLK : in  STD_LOGIC;
          Q : out STD_LOGIC;
          Qneg : out STD_LOGIC);
end Gate2;

architecture BEHAVIORAL of Gate2 is
begin
    process (CLK,D)
    begin
        if rising_edge(CLK) then
            if D='1' then Q<='1';
            Qneg<='0';
```

```
        else Q<='0';  
        Qneg<='1';  
        end if;  
    end if;  
    end process;  
end BEHAVIORAL;
```

(5 marks)

Total Marks for Question B3 = 30

Diwedd/End



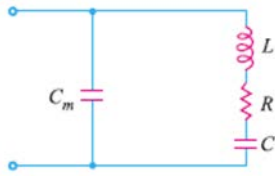
EXAMINATION SOLUTIONS
(to accompany the examination paper sent to the external examiner
but NOT to be seen by students)

Programme:	HNC in Electrical & Electronic Engineering	Level:	5
Module:	PSDE5006 Electronics II		
Author:	M Hall	Page:	Page 1 of

Part A	Question	Marks
A1	$A_v = 20\log 750 = 57.5\text{dB}$	2
	$A_p = 10\log 2000 = 33\text{dB}$	2
A2	$P_{in} = P_{out} / \text{antilog}(4) = 40 / 10000 = 4\text{mW}$	3
A3	$A_{vf} = \frac{A_v}{1 + A_v m_v}$ Rearrange for m_v $m_v = \frac{A_v - A_{vf}}{A_v \times A_{vf}}$ $m_v = \frac{1000 - 50}{1000 \times 50} = 0.019$	3
A4	It uses two capacitors placed in parallel with an inductor L and the centre of the two capacitors is tapped. The tank circuit is made up of C1, C2 and L. When the circuit is turned on, the capacitors C1 and C2 are charged. The capacitors discharge through L, setting up oscillations. The output voltage of the amplifier appears across C1 and feedback voltage is developed across C2. The voltage across it is 180° out of phase with the voltage developed across C1 (Vout). It is easy to see that voltage feedback (voltage across C2) to the transistor provides positive feedback. A phase shift of 180° is produced by the transistor and a further phase shift of 180° is produced by C1-C2 voltage divider. In this way, feedback is properly phased to produce continuous undamped oscillation.	5

A5

Although the crystal has electromechanical resonance, we can represent the crystal action by an equivalent electrical circuit. When the crystal is not vibrating, it is equivalent to capacitance C_m because it has two metal plates separated by a dielectric. This capacitance is known as the mounting capacitance. When a crystal vibrates, it is equivalent to an RLC series circuit. Therefore, the equivalent circuit of a vibrating crystal is RLC series circuit shunted by the mounting capacitance C_m as shown below.



A6

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Rearranging for C1

$$C_1 = \frac{1}{L_1 (2\pi f)^2}$$

$$= \frac{1}{1.5u \times (2\pi \times 200M)^2}$$

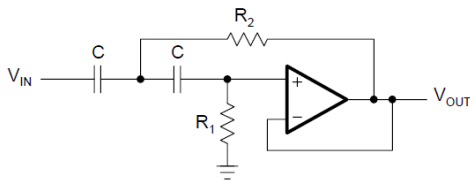
$$= 0.422pF$$

A7

Q = Frequency / Bandwidth

$$= 5M / 75k = 60$$

A8

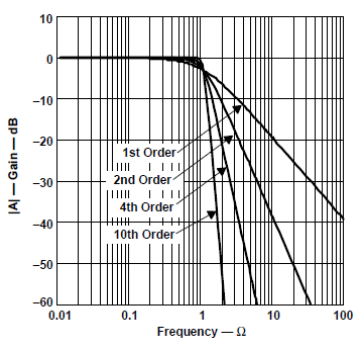
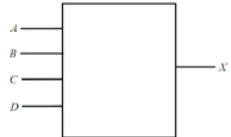


$$R_1 = \frac{1}{\pi f_c \times C \times a_2}$$

$$R_1 = \frac{1}{\pi \times 120k \times 1n \times 1.3617} = 1.95k\Omega$$

$$R_2 = \frac{a_2}{4\pi f_c \times C \times b_2}$$

$$R_2 = \frac{1.3617}{4\pi \times 120k \times 1n \times 0.6180} = 1.07k\Omega$$

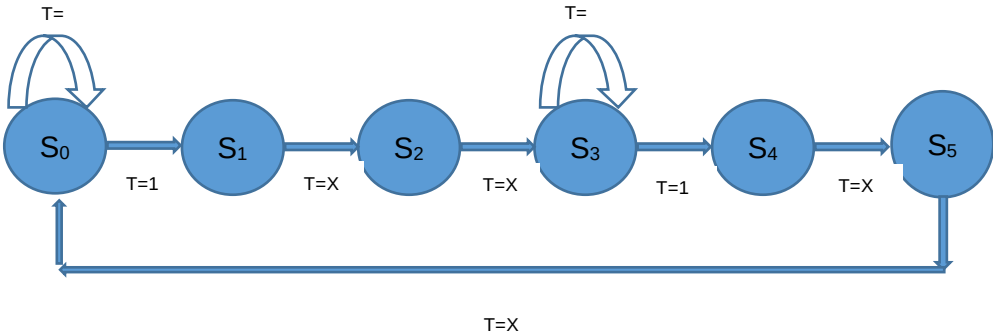
A9	The Butterworth low-pass filter provides maximum passband flatness. Therefore, a Butterworth low-pass is often used as anti-aliasing filter in data converter applications where precise signal levels are required across the entire passband. The rate of roll-off is 20dB/decade.  The graph shows the magnitude response of Butterworth low-pass filters of various orders. The y-axis is labeled ' A — Gain — dB' and ranges from -60 to 10. The x-axis is labeled 'Frequency — Ω' and is on a logarithmic scale from 0.01 to 100. Four curves are shown: 1st Order (roll-off of -20 dB/decade), 2nd Order (roll-off of -40 dB/decade), 4th Order (roll-off of -80 dB/decade), and 10th Order (roll-off of -200 dB/decade). All curves start at 0 dB at Ω = 1 and roll off at higher frequencies.	3 2 1 1 1 1
A10	The inputs are A, B, C, D The output is X The entity is:  The device is a 4 input OR gate	

Q. B1	Question	Marks																														
a.	$A_1 = 20\log 350 = 50.9\text{dB}$ $A_2 = 20\log 100 = 40\text{dB}$ $A_3 = 20\log 175 = 44.9\text{dB}$ Total = 135.8dB	1 1 1 1																														
b.	$V_{\text{out}} = V_{\text{in}} \times \text{antilog}(75/20) = \text{8.44V}$ $P_{\text{load}} = V^2/R = 8.44^2/2000 = \text{35.6mW}$	2 2																														
c.	<u>First Stage</u> $I_{R1} = I_{R2} = V_{\text{cc}} / (R_1 + R_2) = 15/122\text{k} = 123\mu\text{A}$ $V_{B1} = V_{R2} = I_{R2} \times R_2 = 123\mu \times 22\text{k} = \text{2.7V}$ $V_{E1} = V_{B1} - 0.7 = \text{2V}$ $I_{R4} = V_{E1} / R_4 = 2 / 4.7\text{k} = 426\mu\text{A}$ Assuming $I_{C1} = I_{R4}$, then $V_{C1} = V_{\text{CC}} - I_{C1}R_3 = 15 - (426\mu \times 22\text{k}) = \text{5.63V}$ <u>Second Stage</u> $V_{B2} = V_{C1} = 5.63\text{V}$ $V_{E2} = V_{B2} - 0.7 = 4.93\text{V}$ $I_{R6} = V_{E2} / R_6 = 493\mu\text{A}$ Assuming $I_{C2} = I_{R6}$, then $V_{C2} = V_{\text{CC}} - I_{C2}R_5 = 15 - (493\mu \times 10\text{k}) = \text{10.07V}$	2 1 2																														
d.	$A_{vf} = \frac{A_v}{1 + A_v m_v}$ $= \frac{2200}{1 + (2200 \times 0.015)} = \text{64.7}$	3 3																														
e.	<table><tr><th>S. No</th><th>Particular</th><th>RC coupling</th><th>Transformer coupling</th><th>Direct coupling</th></tr><tr><td>1.</td><td>Frequency response</td><td>Excellent in the audio frequency range</td><td>Poor</td><td>Best</td></tr><tr><td>2.</td><td>Cost</td><td>Less</td><td>More</td><td>Least</td></tr><tr><td>3.</td><td>Space and weight</td><td>Less</td><td>More</td><td>Least</td></tr><tr><td>4.</td><td>Impedance matching</td><td>Not good</td><td>Excellent</td><td>Good</td></tr><tr><td>5.</td><td>Use</td><td>For voltage amplification</td><td>For power amplification</td><td>For amplifying extremely low frequencies</td></tr></table>	S. No	Particular	RC coupling	Transformer coupling	Direct coupling	1.	Frequency response	Excellent in the audio frequency range	Poor	Best	2.	Cost	Less	More	Least	3.	Space and weight	Less	More	Least	4.	Impedance matching	Not good	Excellent	Good	5.	Use	For voltage amplification	For power amplification	For amplifying extremely low frequencies	4
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4.	Impedance matching	Not good	Excellent	Good																												
5.	Use	For voltage amplification	For power amplification	For amplifying extremely low frequencies																												

f.	$f_r = \frac{1}{2\pi\sqrt{LC}}$ $= \frac{1}{2\pi \times \sqrt{35m \times 0.22u}}$ $= 5.7\text{KHz}$	3
g.	$BW = \frac{f_0}{Q}$ $= 1.5\text{M} / 75 = 25\text{kHz}$ Lower frequency = $f - \frac{1}{2} \text{ Bandwidth} = 1.5\text{M} - 10\text{k} = 2.9875\text{MHz}$ Upper frequency = $f + \frac{1}{2} \text{ Bandwidth} = 1.5\text{M} + 10\text{k} = 3.0125\text{MHz}$	2 1 1

Q.B2	Question	Marks
a.	$a_1 = 5.6334$ $a_2 = 0.762, \quad b_2 = 2.653$ $a_3 = 0.1172, \quad b_3 = 1.0686$ <u>Stage 1</u> $R_1 = \frac{a_1}{2\pi f_c C_1}$ $= \frac{5.6334}{2\pi \times 2M \times 330p}$ = 1.36kΩ <u>Stage 2</u> $C_2 \geq \frac{C_1 \times 4b}{a^2}$ $\geq \frac{330p \times 4 \times 2.653}{0.762^2} \geq 6nF$ Taking C2 as 7nF (student may choose differently) $R2 = \frac{0.762 \times 7n - \sqrt{(0.762 \times 7n)^2 - 4 \times 2.653 \times 330p \times 7n}}{4\pi \times 50k \times 330p \times 7n} = 2.3k\Omega$ $R3 = \frac{0.762 \times 7n + \sqrt{(0.762 \times 7n)^2 - 4 \times 2.653 \times 330p \times 7n}}{4\pi \times 50k \times 330p \times 7n} = 5.04k\Omega$ <u>Stage 3</u> $C_2 \geq \frac{C_1 \times 4b}{a^2}$ $\geq \frac{330p \times 4 \times 1.0686}{0.1172^2} \geq 103nF$ Taking C2 as 120nF (student may choose differently) $R4 = \frac{0.1172 \times 7n - \sqrt{(0.1172 \times 7n)^2 - 4 \times 1.0686 \times 330p \times 7n}}{4\pi \times 50k \times 330p \times 7n} = 351\Omega$ $R5 = \frac{0.1172 \times 7n + \sqrt{(0.1172 \times 7n)^2 - 4 \times 1.0686 \times 330p \times 7n}}{4\pi \times 50k \times 330p \times 7n} = 780\Omega$	1 1 1 1 1 2 1 3 3 1 1 2 2

b.	$m_v = \frac{C_1}{C_2}$ $0.2 = C_1/C_2$, therefore $C_2 = 5C_1$ $f = \frac{1}{2\pi\sqrt{LC_T}}$ Rearranging for C_T $C_T = \frac{1}{L(2\pi f)^2}$ $= \frac{1}{3m \times (2\pi \times 2.2M)^2} = 1.74pF$ $C_T = \frac{C_1 C_2}{C_1 + C_2}$ Dividing top and bottom by C_1 gives $\frac{C_2}{1 + \frac{C_2}{C_1}}$ If $C_1/C_2 = 0.2$, then $C_2/C_1 = 5$ and $1.74p = \frac{C_2}{1 + 5} = \frac{C_2}{6}$ $\therefore C_2 = 1.74p \times 6 = 10.5pF$ and $C_1 = \frac{C_2}{5} = 2.1pF$	2 3 1 1 1 1
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Q. B3	Question	Marks																																																																																																																																																																																																																													
a.	<u>Allocate states and draw state diagram</u> $S_0 = \text{Red}, S_1 = \text{Red/Amber}, S_2 = \text{Red/amber}, S_3 = \text{Green}, S_4 = \text{Amber}, S_5 = \text{Amber}$  <u>Draw State table</u> <table><thead><tr><th rowspan="3">Current</th><th colspan="2">Next</th><th colspan="6">Next</th><th colspan="3" rowspan="2">Output</th></tr><tr><th rowspan="2">T=0</th><th rowspan="2">T=1</th><th colspan="3">T=0</th><th colspan="3">T=1</th></tr><tr><th>Q_A^+</th><th>Q_B^+</th><th>Q_C^+</th><th>Q_A^+</th><th>Q_B^+</th><th>Q_C^+</th><th>R</th><th>A</th><th>G</th></tr></thead><tbody><tr><td>S0</td><td>S0</td><td>S1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>S1</td><td>S2</td><td>S2</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>S2</td><td>S3</td><td>S3</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr><tr><td>S3</td><td>S3</td><td>S4</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>S4</td><td>S5</td><td>S5</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>S5</td><td>S0</td><td>S0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr></tbody></table> <u>Draw Karnaugh Maps</u> Q_A^+ <table><thead><tr><th>BC</th><th>00</th><th>01</th><th>11</th><th>10</th></tr></thead><tbody><tr><td>00</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>01</td><td>1</td><td>0</td><td>X</td><td>X</td></tr><tr><td>11</td><td>1</td><td>0</td><td>X</td><td>X</td></tr><tr><td>10</td><td>0</td><td>0</td><td>1</td><td>0</td></tr></tbody></table> Q_B^+ <table><thead><tr><th>BC</th><th>00</th><th>01</th><th>11</th><th>10</th></tr></thead><tbody><tr><td>00</td><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>01</td><td>0</td><td>0</td><td>X</td><td>X</td></tr><tr><td>11</td><td>0</td><td>0</td><td>X</td><td>X</td></tr><tr><td>10</td><td>0</td><td>1</td><td>0</td><td>1</td></tr></tbody></table> Q_C^+ <table><thead><tr><th>BC</th><th>00</th><th>01</th><th>11</th><th>10</th></tr></thead><tbody><tr><td>00</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>01</td><td>1</td><td>0</td><td>X</td><td>X</td></tr><tr><td>11</td><td>1</td><td>0</td><td>X</td><td>X</td></tr><tr><td>10</td><td>1</td><td>0</td><td>0</td><td>1</td></tr></tbody></table> Red <table><thead><tr><th>BC</th><th>00</th><th>01</th><th>11</th><th>10</th></tr></thead><tbody><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td><td>X</td><td>X</td></tr></tbody></table> Amber <table><thead><tr><th>BC</th><th>00</th><th>01</th><th>11</th><th>10</th></tr></thead><tbody><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>X</td><td>X</td></tr></tbody></table> Green <table><thead><tr><th>BC</th><th>00</th><th>01</th><th>11</th><th>10</th></tr></thead><tbody><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>X</td><td>X</td></tr></tbody></table>	Current	Next		Next						Output			T=0	T=1	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	BC	00	01	11	10	00	0	0	0	0	01	1	0	X	X	11	1	0	X	X	10	0	0	1	0	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	BC	00	01	11	10	00	0	0	1	1	01	1	0	X	X	11	1	0	X	X	10	1	0	0	1	BC	00	01	11	10	0	1	1	0	1	1	0	0	X	X	BC	00	01	11	10	0	0	1	1	0	1	1	1	X	X	BC	00	01	11	10	0	0	0	1	0	1	0	0	X	X	1
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Derive Boolean Expressions

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

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

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

$$Red = \bar{A}\bar{B} + B\bar{C}$$

$$Amber = A + C$$

$$Green = BC$$

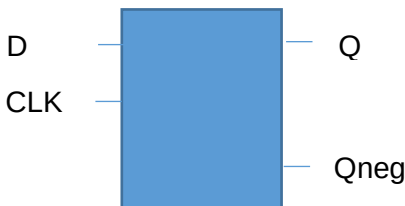
b.i

The inputs are D and CLK.

The outputs are Q and Qneg

ii.

The entity is:



iii.

Q	D	Q(t+1)
0	0	0
0	1	1
1	0	0
1	1	1