UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME : ELECTRONIC CIRCUITS ANALYSIS AND DESIGN

COURSE CODE : BEL 30403

PROGRAMME CODE : BEJ

EXAMINATION DATE : DECEMBER 2018 / JANUARY 2019

DURATION : 3 HOURS

INSTRUCTION : ANSWERS **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

TERBUKA

Q1 (a) Derive the output voltage, V_o for the circuit shown in **Figure Q1(a)**.

(5 marks)

(b) Analyse the output voltage, V_o for the circuit in **Figure Q1(b)**.

(5 marks)

(c) Explain why Schmitt Trigger circuit is better than a comparator circuit.

(2 marks)

(d) For the circuit **Figure Q1(c)**, given $V_{z1} = 4.1\ V, V_{z2} = 5.6\ V$ and $V_D = 0.7\ V$.

(i) Analyse the input waveform, V_i and the output waveform, V_o.

(5 marks)

(ii) Draw the input waveform, V_i and the output waveform, V_o.

(3 marks)

Q2 (a) Explain the important of -3dB gain point in the analysis of active filter response.

(4 marks)

(b) A filter circuit is depicted in **Figure Q2(b)**.

(i) Derive the gain transfer function of the circuit:

$$H(\omega) = A(\omega) = \frac{V_o\,(\omega)}{V_i\,(\omega)}$$

(6 marks)

(ii) Analyse the circuit by finding the gain of the circuit at the following frequencies: $\omega = 0$ and $\omega = \infty$.

(4 marks)

(iii) Draw the frequency response graph of the circuit and determine the type of the filter.

(3 marks)

(iv) Determine the type of the filter.

(1 mark)

(v) Calculate the cut-off frequency if R_1 = 2.2 kΩ, R_2 = 15 kΩ, and C = 0.068 μF.

(2 marks)

Q3 (a) Explain on how an amplifier that has a negative feedback is much better than an amplifier without a negative feedback in term of:

(i) gain

(3 marks)

(ii) bandwidth

(3 marks)

(b) For the circuit shown in **Figure Q3(b)**,

(i) Analyse the type of the amplifier and the feedback topology used.

(4 marks)

(ii) Calculate the feedback factor, β of the amplifier and its gain with feedback, A_F.

(10 marks)

Q4 (a) By assuming all the diodes in **Figure Q4(a)** are ideal,

(i) Analyse the frequency of the output waveform, V_O

(7 marks)

(ii) Draw the output waveform, V_O and the voltage of the capacitor, V_C. Draw both waveforms parallel at x-axis and show clearly the relationship between these two waveforms. Also clearly label the waveforms.

(6 marks)

(b) Design a circuit using 555 timer that will produce an output as shown in **Figure Q4(b)**. Show the complete circuitry with labels. Use a capacitor value of 0.01µF.

(7 marks)

Q5 **Figure Q5(a)** is a full wave bridge circuit with a capacitor filter and the output waveform produced by the circuit is shown in **Figure Q5(b)**. Assume all the diodes in the circuit have a forward voltage of 0.7 V.

(a) Design the circuit by finding the value for the capacitor, C and the line voltage $V_{pri(rms)}$ to the circuit to produce the output as shown in **Figure Q5(b)**.

(9 marks)

(b) Calculate the ripple factor for the circuit in **Figure Q5(a)**.

(2 marks)

(c) An additional RC filter with a 100 μF capacitor is added to the circuit in **Figure Q5(a)** to produce a new output DC voltage of 10V.

(i) Modify the circuit to include the additional RC filter. Draw the new circuit and completely label the circuit. Determine the value for the resistor of the additional RC filter.

(5 marks)

(ii) Find the new ripple factor of the circuit and compare with the ripple in **Q5(b)**. Draw a conclusion from this comparison.

(4 marks)

- END OF QUESTIONS -

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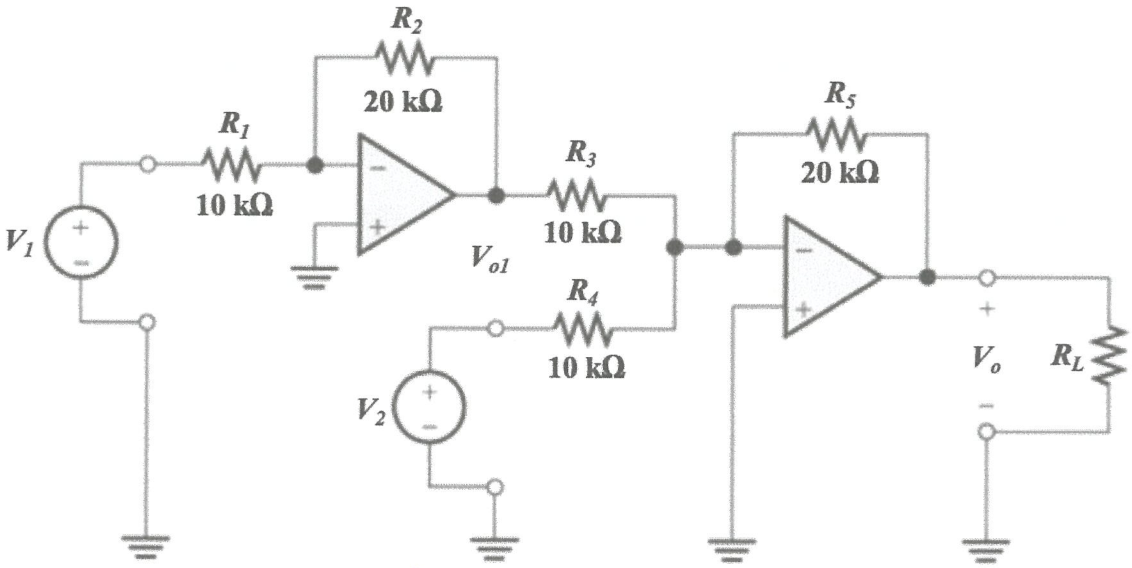

Figure Q1(a)

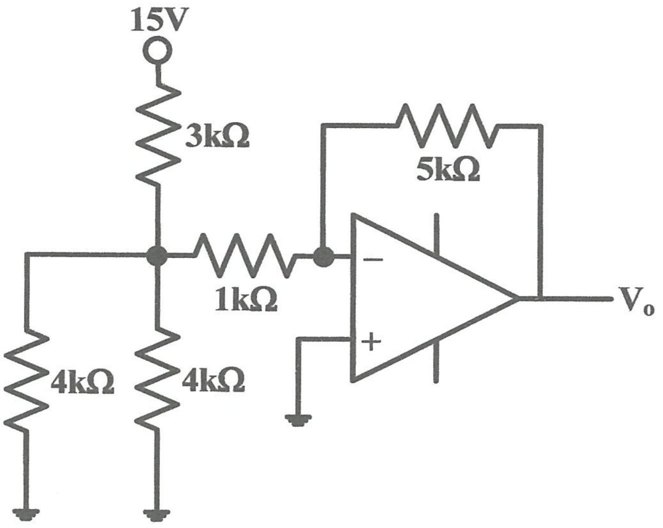

Figure Q1(b)

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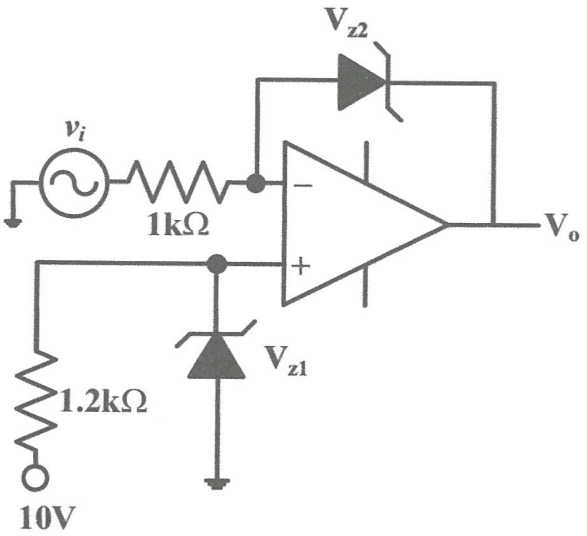

Figure Q1(c)

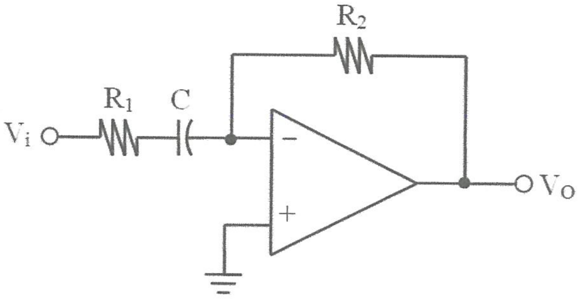

Figure Q2(b)

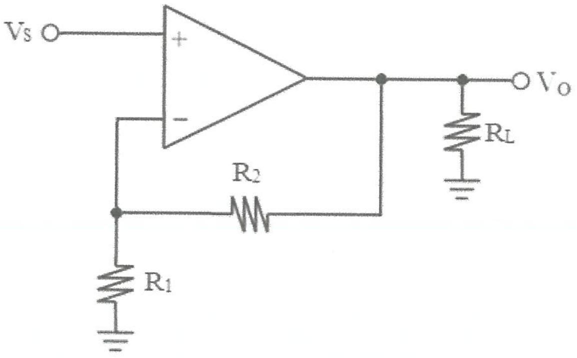

Figure Q3(b)

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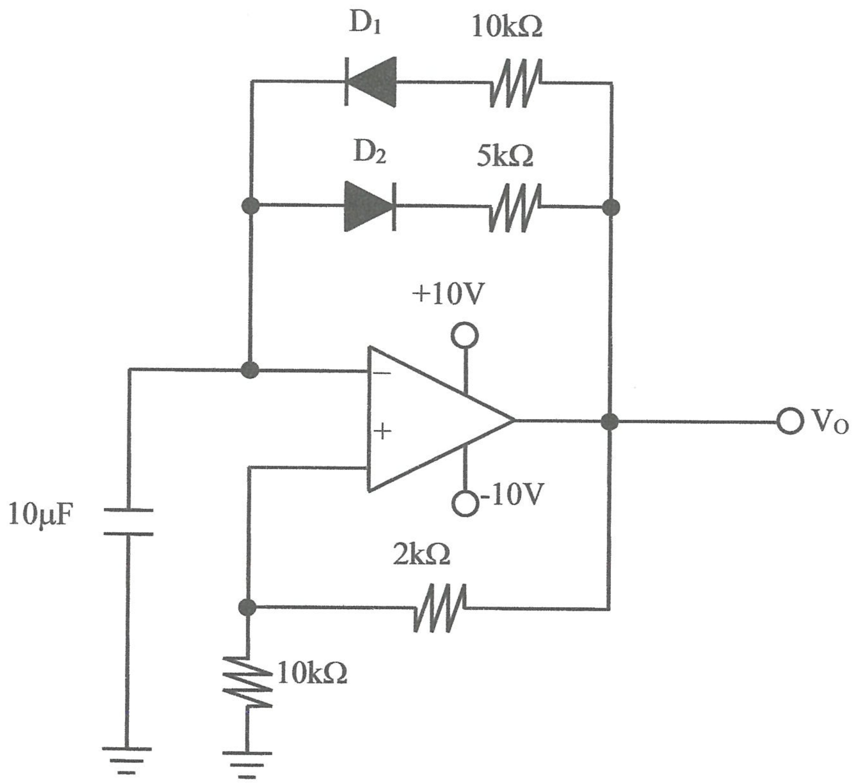

Figure Q4(a)

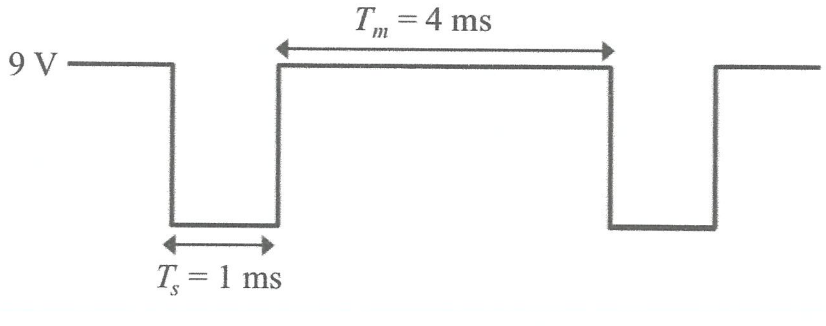

Figure Q4(b)

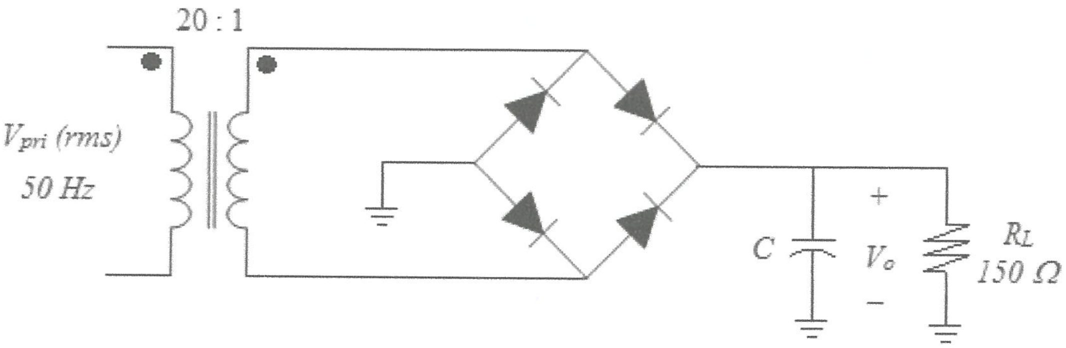

Figure Q5(a)

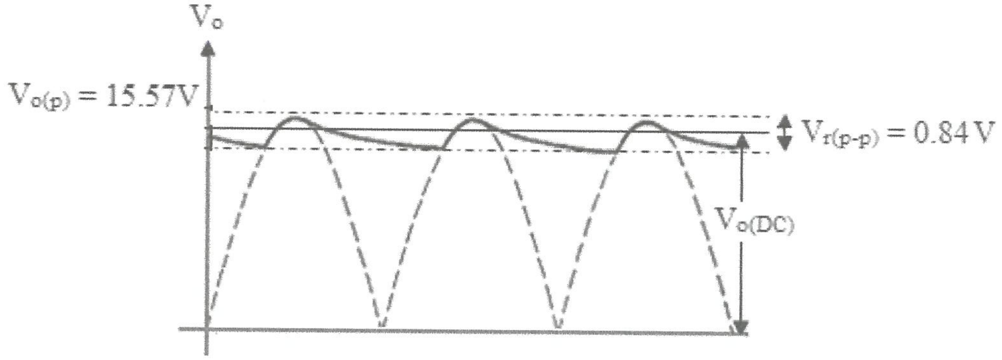

Figure Q5(b)

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Table 1 List of formula

Inverting Amplifier	$A_V = \frac{V_o}{V_i} = -\frac{R_f}{R_1}$
Non-Inverting Amplifier	$A_V = \frac{V_o}{V_i} = 1 + \frac{R_f}{R_1}$
Inverting Summing Amplifier	$V_o = -\left(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2 + \frac{R_f}{R_3}V_3\right)$
Non-Inverting Summing Amplifier	$V_o = \left(1 + \frac{R_f}{R_1}\right)\left(\frac{R_B}{R_A + R_B}V_A + \frac{R_A}{R_A + R_B}V_B\right)$
Subtracting Amplifier	$V_o = \left(1 + \frac{R_f}{R_1}\right)\left(\frac{R_3}{R_2 + R_3}V_2 - \frac{R_f}{R_1 + R_f}V_1\right)$
Instrumentation Amplifier	$A_T = A_1 A_2 = \frac{v_o}{v_{in}} = \left(1 + \frac{2R}{R_x}\right)\left(\frac{R_4}{R_3}\right)$
Integrator	$V_o(t) = -\frac{1}{RC}\int_{t_0}^{t_1} V_i(t)\, dt + V_o(t_0)$
Differentiator	$V_o(t) = -RC\frac{dV_i(t)}{dt}$
Schmitt Trigger	$V_{UTP \text{ or } LTP} = \frac{R_2}{R_1 + R_2}(\pm V_{out(\max)}) + \frac{R_1}{R_1 + R_2}(V_{REF})$
Cut-off frequency for a filter	$f_c = \frac{1}{2\pi RC}$
1st order Low Pass Filter	$A_V(s) = \frac{V_o}{V_i} = \left(1 + \frac{R_F}{R_1}\right)\left(\frac{1}{1 + sRC}\right)$
2nd order Low pass filter	$A_V(s) = \frac{V_o}{V_i}(s) = \frac{A_{VO}}{(RCs)^2 + (3 - A_{VO})RCs + 1}$
1st order High Pass Filter	$A_V(s) = \frac{V_o}{V_i} = \left(1 + \frac{R_F}{R_1}\right)\left(\frac{1}{1 + \frac{1}{sRC}}\right)$

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Table 1 List of formula (Cont..)

2nd order High Pass Filter	$A_V(s) = \frac{V_O}{V_i}(s) = \frac{A_{VO}}{\frac{1}{(sRC)^2} + \frac{3-A_{VO}}{sRC} + 1}$
Negative feedback – Gain	$A_f = \frac{V_o}{V_S} = \frac{A}{1+\beta A}$
Positive feedback – Gain	$A_f = \frac{A}{1-\beta A}$
Phase shift oscillator	$\beta = \frac{V_F}{V_o} = \frac{1}{\left(1-\frac{5}{\omega^2 R^2 C^2}\right) + j\left(\frac{1}{\omega^3 R^3 C^3} - \frac{6}{\omega RC}\right)}$ or $\beta = \frac{V_F}{V_o} = \frac{1}{\left(1-5\omega^2 R^2 C^2\right) + j\left(6\omega RC - \omega^3 R^3 C^3\right)}$ $f_o = \frac{1}{2\pi RC\sqrt{6}}$ or $f_o = \frac{\sqrt{6}}{2\pi RC}$
Wien bridge oscillator	$f_o = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$
Colpitts Oscillator	$f_o = \frac{1}{2\pi\sqrt{LC_{eq}}}$ $C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$
Hartley Oscillator	$f_o = \frac{1}{2\pi\sqrt{CL_{eq}}}$ $L_{eq} = L_1 + L_2$
UJT relaxation oscillator	$f_o = \frac{1}{R_T C_T \ln\left[1/(1-\eta)\right]}$

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Table 1 List of formula (Cont..)

Square-wave Oscillator	$f=\frac{1}{T}=\frac{1}{2RC\ln\left(\frac{1+\beta}{1-\beta}\right)}$ $\beta=\frac{R_3}{R_3+R_2}$
Triangular-wave Oscillator	$f=\frac{1}{4R_1C}\frac{R_2}{R_3}$
Capacitor voltage	$v_c(t)=v_c(0)+\left(v_c(\infty)-v_c(0)\right)\left(1-e^{-t/\tau}\right)$ $=v_c(\infty)+\left(v_c(0)-v_c(\infty)\right)e^{-t/\tau}$
Astable Multivibrator	$T_m=t_1=\tau_2\ln 2=0.693\left(R_1+R_2\right)C_1$ $T_s=t_2=\tau_2\ln 2=0.693R_2C_1$ $T=T_m+T_s$ $f=\frac{1.44}{(R_1+2R_2)C_1}$ $D=\frac{T_m}{T_m+T_s}\times 100\%=\frac{R_1+R_2}{R_1+2R_2}\times 100\%$
Monostable Multivibrator	$T=1.1\,R_1C_1$
Ripple Factor	$\%\,r=\frac{\text{ripple voltage (rms)}}{\text{dc voltage}}=\frac{V_{r(rms)}}{V_{dc}}\times 100$
Half-wave rectifier with a filter	$V_{r(rms)}=\frac{V_{r(p-p)}}{2\sqrt{3}}\approx\frac{V_{o(p)}}{2\sqrt{3}fCR_L}$ $V_{o(DC)}=V_{o(p)}-\frac{V_{r(p\text{-}p)}}{2}$ $V_{r(p\text{-}p)}\approx\frac{V_{o(p)}}{fCR_L}=\frac{I_{o(DC)}}{fC}$ $r=\frac{V_{r(rms)}}{V_{DC}}\approx\frac{1}{2\sqrt{3}fCR_L}$ $I_{o(DC)}=\frac{V_{o(DC)}}{R_L}\approx\frac{V_{o(p)}}{R_L}$

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Table 1 List of formula (Cont..)

Full-wave rectifier with a filter	$V_{r(rms)} = \frac{V_{r(p-p)}}{2\sqrt{3}} \approx \frac{V_{o(p)}}{4\sqrt{3}fCR_L} = \frac{I_{o(DC)}}{4\sqrt{3}fC}$ $V_{o(DC)} = V_{o(p)} - \frac{V_{r(p-p)}}{2}$ $V_{r(p-p)} = \frac{I_{o(DC)}}{2fC} \approx \frac{V_{o(p)}}{2fCR_L}$ $r = \frac{V_{r(rms)}}{V_{DC}} \approx \frac{1}{4\sqrt{3}fCR_L}$ $I_{o(DC)} = \frac{V_{o(DC)}}{R_L} \approx \frac{V_{o(p)}}{R_L}$
Rectifier with Additional RC filter	$V'_{r(rms)} \approx \frac{X_C}{R} V_{r(rms)}$
Inductor Filter	$r = \frac{R_L}{3\sqrt{2}\omega L}$
Shunt regulator	$V_o \cong V_B\left(\frac{R_1+R_2}{R_2}\right)$ $V_B = V_Z + V_{BE}$ $V_o \cong \left(\frac{R_1+R_2}{R_2}\right)(V_Z)$
Series regulator	$V_o = \frac{R_1+R_2}{R_1}(V_Z + V_{BE})$ $V_o = V_Z\left(\frac{R_1+R_2}{R_1}\right)$
Adjustable IC regulator	$V_o = V_{ref}\left(1+\frac{R_2}{R_1}\right) + I_{adj}R_2$