UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	ELECTRONIC CIRCUITS ANALYSIS AND DESIGN
COURSE CODE	:	BEL 30403
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JUNE/JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 Analyse the circuit shown in **Figure Q1,**

(a) Name the function of each Op-Amp, A1, A2, A3, and A4.

(2 marks)

(b) (i) Determine the output for each Op-Amp (V_{01}, V_{02}, V_{03} and V_{04}).

(10 marks)

(ii) Draw all the waveforms based on answer in part **Q1(b)(i).**

(8 marks)

Q2 An active filter is shown in **Figure Q2**. Based on this circuit;

(a) Name the type and order of the filter.

(1 mark)

(b) Formulate the transfer function $H(s) = V_o(s)/V_i(s)$.

(7 marks)

(c) Calculate the gain in dB at the passband and determine the cut-off frequencies of this filter when $R_1 = 3.3\ k\Omega$, $R_2 = 100\ k\Omega$, $C_1 = 1.5\ \mu F$ and $C_2 = 68\ pF$.

(7 marks)

(d) Sketch the frequency response of the overall filter circuit and label its cutoff frequencies and gain in dB.

(5 marks)

Q3 (a) Explain **TWO (2)** differences between system with positive feedback and system with negative feedback.

(2 marks)

(b) With the aid of a block diagram, derive the closed-loop gain, A_f of a negative feedback system.

(8 marks)

(c) An amplifier with a negative feedback has a midband gain of 47.96 dB and low cutoff frequency of 75 Hz. The feedback network of the system has a feedback factor (β) of 0.0022.

(i) Determine the midband gain and the low cutoff frequency if the amplifier does not have a feedback network.

(7 marks)

(ii) Sketch the frequency response for both systems and label it clearly.

(3 marks)

Q4 (a) (i) Explain the Barkhausen Criterion for an oscillator circuit.

(2 marks)

(ii) Describe the performance of an oscillator circuit if the loop gain falls below 1 and also if the loop gain is greater than 1.

(2 marks)

(b) An inverting amplifier circuit using Op-Amp 741 IC, a feedback resistor R_F = 145 kΩ and input resistance, R_A is used in a feedback oscillator circuit. The output pin of the amplifier is connected to the three RC network that can generate frequency of oscillation of 50 kHz. Assume that $R_1 = R_2 = R_3 = R$ and $C_1 = C_2 = C_3 = C$.

(i) Name the oscillator circuit.

(1 mark)

(ii) Draw the oscillator circuit.

(3 marks)

(iii) Using a capacitor value of 0.001 μF, design the circuit by finding all other component values.

(4 marks)

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

(6 marks)

(ii) Calculate the duty cycle.

(2 marks)

Q5 A voltage regulator circuit with an input voltage (V_i) of 36 V and regulated output voltage (V_o) of 24 V is shown in **Figure Q5**.

The Zener diode used is 1N4733A which has the following parameters:

$V_Z = 5.1$ V $\quad I_{Z(min)} = 1$ mA $\quad I_{Z(max)} = 178$ mA

The transistor's parameters: $I_{C(min)} = 1$ mA and $I_{C(max)} = 80$ mA.

(a) Design the voltage regulator circuit shown in **Figure Q5**. Find the values of R_A, R_B, and range of R_S that can be used in the circuit, such that the regulated output voltage is maintained at 24 V.

(9 marks)

(b) Determine the power rating for the transistor to be used in the circuit. Assume the input voltage (V_i) is fixed at 36 V.

(6 marks)

(c) Explain the operation of the circuit as a voltage regulator when the regulated output is slightly increased from the stated regulated value.

(5 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

SEMESTER / SESSION	: SEM II / 2017/2018	PROGRAMME CODE	: BEJ
COURSE NAME	: ELECTRONIC CIRCUITS ANALYSIS AND DESIGN	COURSE CODE	: BEL 30403

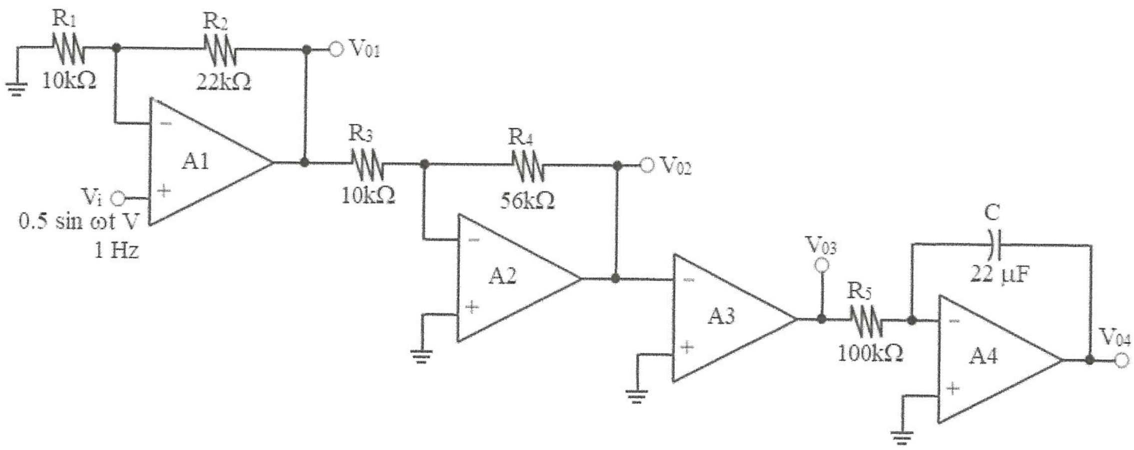

Figure Q1

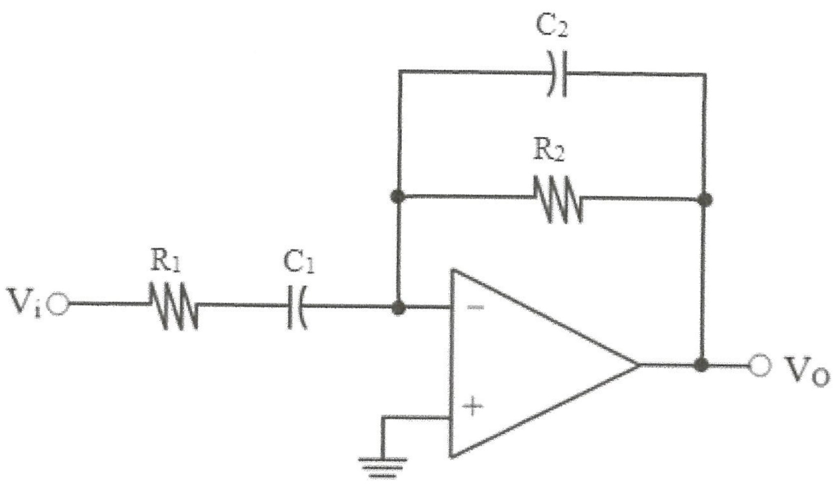

Figure Q2

FINAL EXAMINATION

SEMESTER / SESSION	: SEM II / 2017/2018	PROGRAMME CODE	: BEJ
COURSE NAME	: ELECTRONIC CIRCUITS ANALYSIS AND DESIGN	COURSE CODE	: BEL 30403

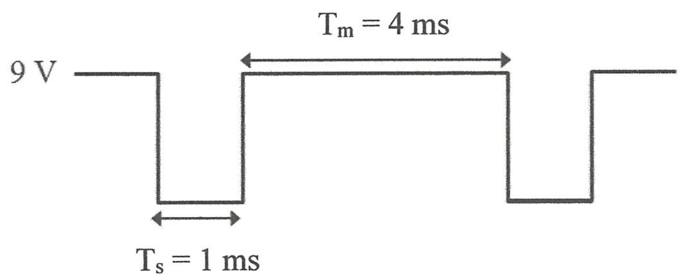

Figure Q4(c)

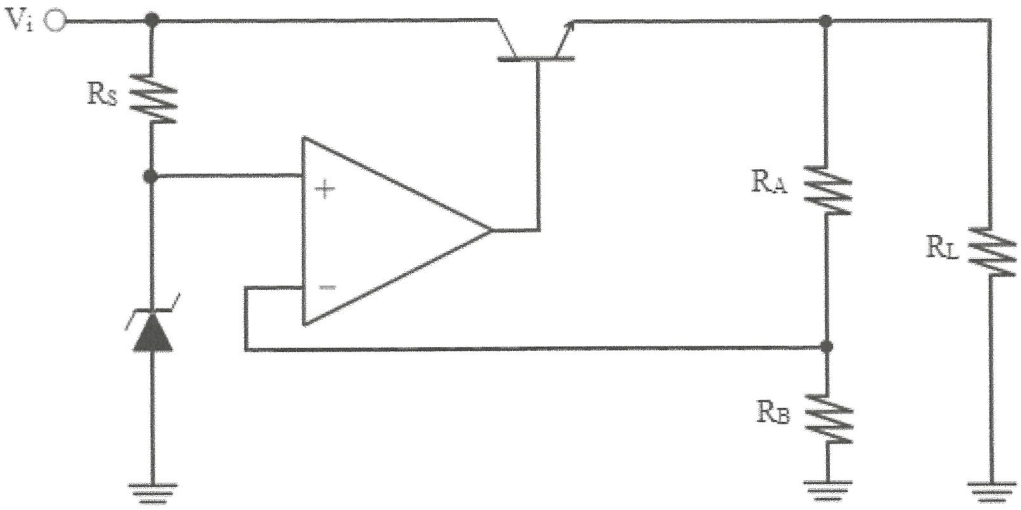

Figure Q5

FINAL EXAMINATION

SEMESTER / SESSION	: SEM II / 2017/2018	PROGRAMME CODE	: BEJ
COURSE NAME	: ELECTRONIC CIRCUITS ANALYSIS AND DESIGN	COURSE CODE	: BEL 30403

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	$A_V(s) = \frac{V_o}{V_i} = \left(1 + \frac{R_F}{R_1}\right)\left(\frac{1}{1 + \frac{1}{sRC}}\right)$

FINAL EXAMINATION	
SEMESTER / SESSION : SEM II / 2017/2018 COURSE NAME : ELECTRONIC CIRCUITS ANALYSIS AND DESIGN	PROGRAMME CODE : BEJ COURSE CODE : BEL 30403

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	$\beta = \frac{V_F}{V_o} = \frac{1}{\left(1-\frac{5}{\omega^2R^2C^2}\right) + j\left(\frac{1}{\omega^3R^3C^3} - \frac{6}{\omega RC}\right)}$ or $\beta = \frac{V_F}{V_o} = \frac{1}{\left(1-5\omega^2R^2C^2\right) + j\left(6\omega RC - \omega^3R^3C^3\right)}$ $f_o = \frac{1}{2\pi RC\sqrt{6}}$ or $f_o = \frac{\sqrt{6}}{2\pi RC}$
Wien bridge oscillator	$f_o = \frac{1}{2\pi\sqrt{R_1R_2C_1C_2}}$
Colpitts Oscillator	$f_o = \frac{1}{2\pi\sqrt{LC_{eq}}}$ $C_{eq} = \frac{C_1C_2}{C_1+C_2}$
Hartley Oscillator	$f_o = \frac{1}{2\pi\sqrt{CL_{eq}}}$ $L_{eq} = L_1 + L_2$
UJT relaxation oscillator	$f_o = \frac{1}{R_TC_T \ln[1/(1-\eta)]}$

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2017/2018 PROGRAMME CODE : BEJ
COURSE NAME : ELECTRONIC CIRCUITS ANALYSIS AND DESIGN COURSE CODE : BEL 30403

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	$T_m=t_1=\tau_2\ln 2=0.693(R_1+R_2)C_1$ $T_s=t_2=\tau_2\ln 2=0.693R_2C_1$ $T=T_m+T_s$ $f=\frac{1.44}{(R_1+2R_2)C_1}$ $D=\frac{T_m}{T_m+T_s}\times 100\%=\frac{R_1+R_2}{R_1+2R_2}\times 100\%$
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	$V_{r(rms)}=\frac{V_{r(p-p)}}{2\sqrt{3}}\approx\frac{V_{o(p)}}{2\sqrt{3}fCR_L}$ $V_{o(DC)}=V_{o(p)}-\frac{V_{r(p-p)}}{2}$ $V_{r(p-p)}\approx\frac{V_{o(p)}}{fCR_L}=\frac{I_{o(DC)}}{fC}$ $r=\frac{V_{r(rms)}}{V_{DC}}\approx\frac{1}{2\sqrt{3}fCR_L}$

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2017/2018	PROGRAMME CODE : BEJ
COURSE NAME : ELECTRONIC CIRCUITS ANALYSIS AND DESIGN	COURSE CODE : BEL 30403

Table 1 List of formula (Cont..)

Full-wave rectifier with a filter	$V_{r(rms)} = \frac{V_{r(p-p)}}{2\sqrt{3}} \approx \frac{V_{o(p)}}{4\sqrt{3}fCR_L} = \frac{I_{DC}}{4\sqrt{3}fC}$ $V_{o(DC)} = V_{o(p)} - \frac{V_{r(p-p)}}{2}$ $\quad$ $V_{r(p-p)} = \frac{I_{o(DC)}}{2fC} \approx \frac{V_{o(p)}}{2fCR_L}$ $r = \frac{V_{r(rms)}}{V_{DC}} \approx \frac{1}{4\sqrt{3}fCR_L}$
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	$V_o \cong V_B\left(\frac{R_1+R_2}{R_2}\right)$ $\quad$ $V_B = V_Z + V_{BE}$ $V_o \cong \left(\frac{R_1+R_2}{R_2}\right)(V_Z)$
Series regulator	$V_o = \frac{R_1+R_2}{R_1}(V_Z + V_{BE})$ $\quad$ $V_o = V_Z\left(\frac{R_1+R_2}{R_1}\right)$
Adjustable IC regulator	$V_o = V_{ref}\left(1+\frac{R_2}{R_1}\right) + I_{adj}R_2$

TERBUKA