UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2017/2018

TERBUKA

COURSE NAME	:	ELECTRONIC CIRCUITS ANALYSIS AND DESIGN
COURSE CODE	:	BEL 30403
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	DECEMBER 2017 / JANUARY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS ALL QUESTIONS

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

Q1 Based on input signal, V_{in} in **Figure Q1(a)**:

(i) Name the function of each op-omp in **Figure Q1(b)**.

(3 marks)

(ii) Draw and label completely the output waveforms V_{01}, V_{02} and V_{03} by analysing the circuit in **Figure Q1(b)**.

(17 marks)

Q2 (a) **Figure Q2** shows an oscillator circuit using two 555 timers. Assume that the reset pin is active low. When the switch is opened:

(i) Draw the output waveform (V_{01}) of Timer A indicating clearly the ON and OFF time, and calculate the frequency of oscillation of Timer A.

(4 marks)

(ii) Obtain the duty cycle of Timer B.

(3 marks)

(b) Explain the operation of the oscillator when the switch in **Figure Q2** is closed and draw the output waveform of both timers (V_{01} and V_0) for **two (2)** cycles of V_{01}. Indicate clearly the relationship between those two waveforms by drawing them parallel at time axis.

(8 marks)

(c) Redesign the Timer A to be a one shot or monostable multivibrator with a high output of similar time to t_{ON} in **Q2(a)(i)**. State the condition on the input to the monostable multivibrator in order to produce the output.

(5 marks)

Q3 (a) **Figure Q3(a)** shows an Op-Amp amplifier circuit which employs a negative feedback.

(i) Classify the feedback topology used and the type of amplifier in the circuit.

(4 marks)

(ii) Formulate the feedback network (β) and the overall gain of the amplifier with feedback (A_F).

(10 marks)

(b) A current amplifier with an input impedance (z_i) of 5kΩ has an open loop gain (A) of 100k and a high cut-off frequency (f_H) at 15 kHz. The amplifier is connected to a feedback network as shown in **Figure Q3(b)** and the close loop gain (A_F) is 100.

(i) Obtain the closed-loop high cut-off frequency (f_{HF}) for this system.
(4 marks)

(ii) Based on your answer in **Q3(b)(i)**, point out the advantage of having a negative feedback
(2 marks)

Q4 The circuit in **Figure Q4** is an active filter. For this circuit

(i) Derive the expression for the voltage transfer function of the circuit

$$H(s) = \frac{V_O(s)}{V_i(s)}$$

(9 marks)

(ii) Determine the gain of the circuit at DC ($f = 0$ Hz).
(3 marks)

(iii) Find the cut-off frequency for the circuit.
(3 marks)

(iv) Draw the frequency response and then determine the filter type and order.
(5 marks)

Q5 (a) Design a shunt regulator circuit that meets these requirements:

- voltage regulation is achieved by drawing large current from load through a transistor
- the regulated output voltage is 9V
- the input voltage is 15V
- input current shall be twice the load current

Show a complete circuit configuration with values of all required components.
(12 marks)

(b) Analyse the effect to circuit operation if the load resistor is larger than its designed value in **Q5(a)**. Support your analysis with the appropriate examples.
(8 marks)

- END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2017/2018
COURSE NAME : ELECTRONIC CIRCUITS ANALYSIS AND DESIGN

PROGRAMME CODE : BEJ
COURSE CODE : BEL 30403

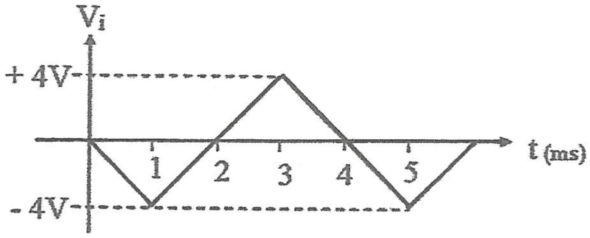

Figure Q1(a)

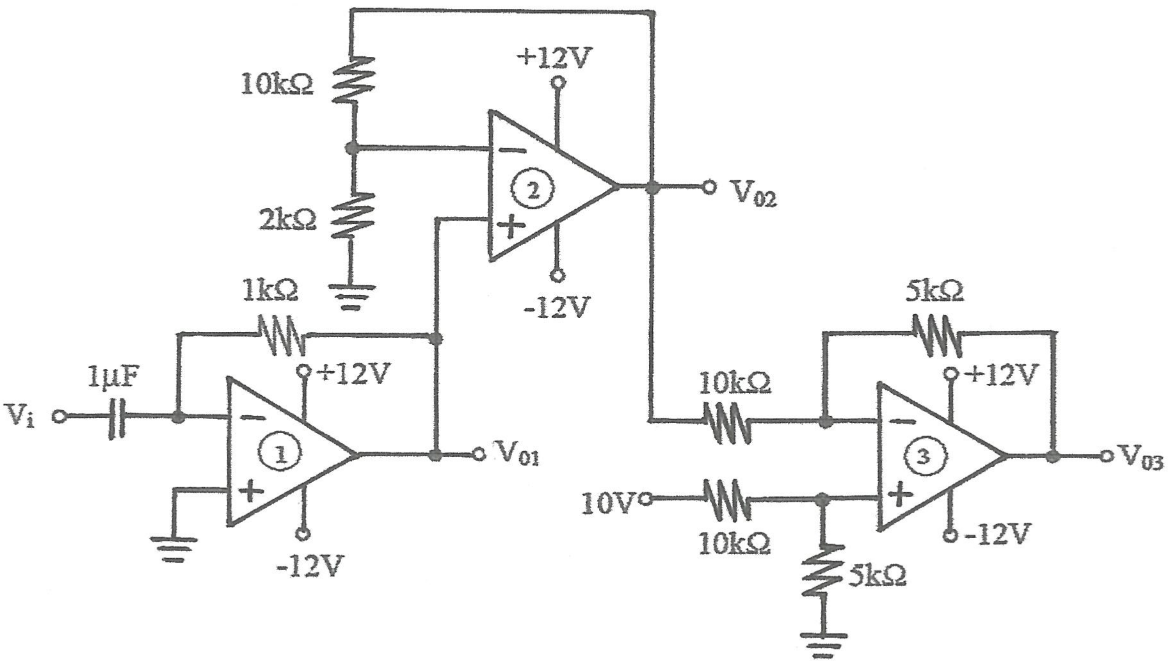

Figure Q1(b)

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

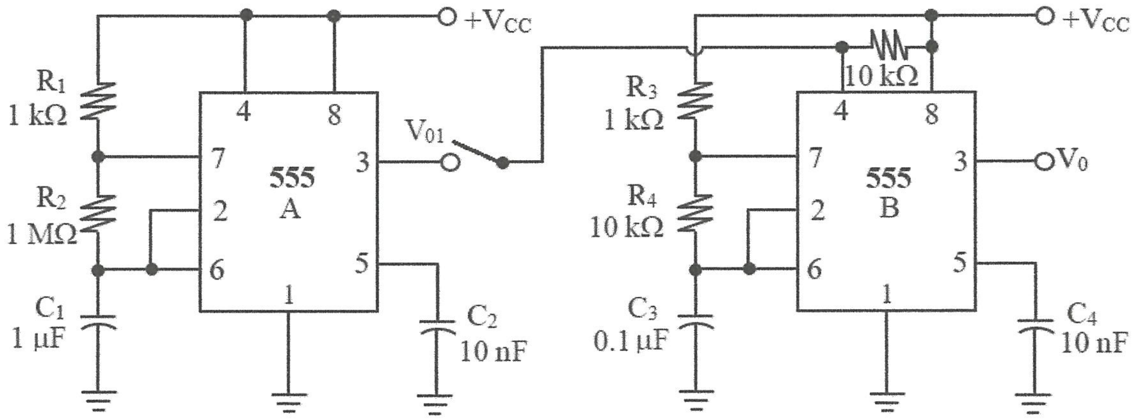

Figure Q2

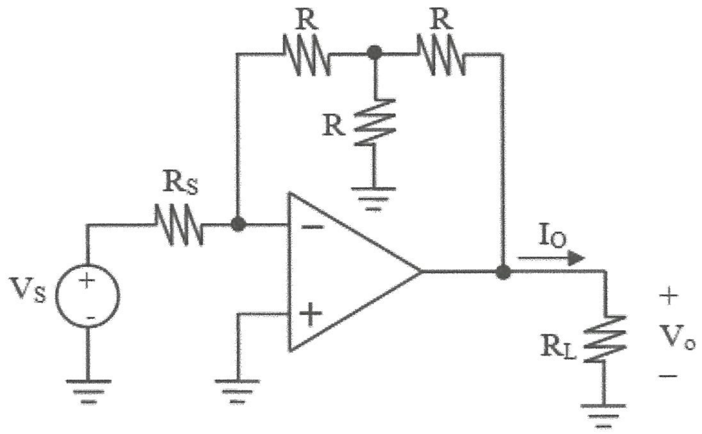

Figure Q3(a)

FINAL EXAMINATION

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

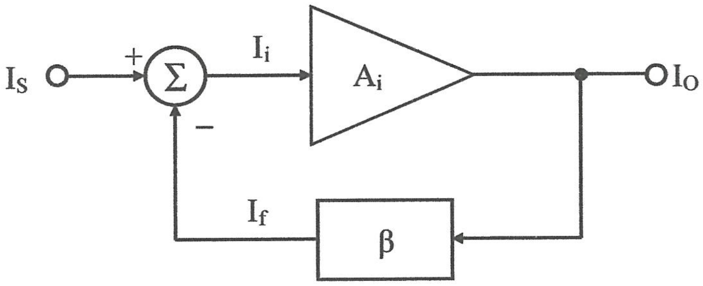

Figure Q3(b)

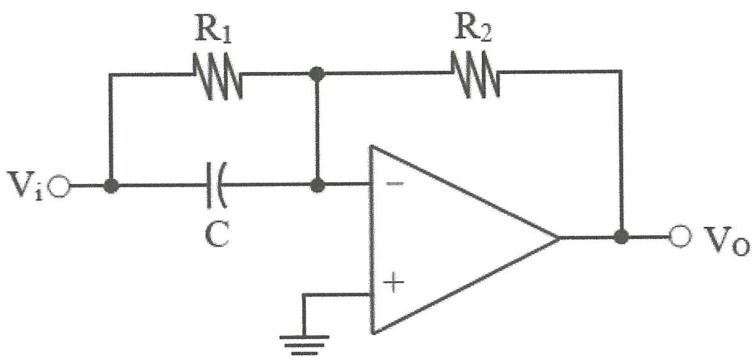

Figure Q4

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 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 I / 2016/2017 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 I / 2016/2017 COURSE NAME : ELECTRONIC CIRCUITS ANALYSIS AND DESIGN	PROGRAMME CODE : BEJ 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 TERBUKA	$V_{r(rms)}=\frac{V_{r(p-p)}}{2\sqrt{3}}\approx\frac{V_{o(p)}}{2\sqrt{3}fCR_L}$ $V_{o(DC)}=V_{o(p)}-\frac{V_{r(p-p)}}{2}$ $V_{r(p-p)}\approx\frac{V_{o(p)}}{fCR_L}=\frac{I_{o(DC)}}{fC}$ $r=\frac{V_{r(rms)}}{V_{DC}}\approx\frac{1}{2\sqrt{3}fCR_L}$

FINAL EXAMINATION

SEMESTER / SESSION : SEM I / 2016/2017
COURSE NAME : ELECTRONIC CIRCUITS ANALYSIS AND DESIGN
PROGRAMME CODE : BEJ
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	$V_o = V_{ref} \left(1 + \frac{R_2}{R_1} \right) + I_{adj} R_2$