KOLEJ UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF ENGINEERING AND TECHNOLOGY

ACADEMIC YEAR 2018/2019

JANUARY/FEBRUARY EXAMINATION

BTEC2313 CIRCUITS ANALYSIS

THURSDAY, 31 JANUARY 2019

TIME: 9.00 AM – 11.30 AM
(2 HOURS 30 MINUTES)

BACHELOR OF ENGINEERING (HONOURS) ELECTRICAL AND ELECTRONICS

Instructions to Candidates:

Answer **ALL** questions.
All questions carry equal marks.

Attachment:
Formula sheet 1

Formula sheet 2

BTEC2313 CIRCUITS ANALYSIS

Question 1

a) For the network shown in Figure Q1 (a), find the power delivered or absorbed by the 12V source using mesh analysis. (10 marks)

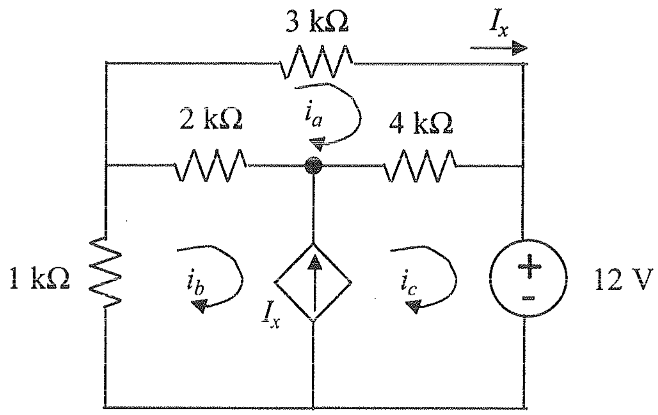

Figure Q1 (a)

b) For the network shown in Figure Q1 (b), use nodal analysis to find voltage at each node. (6 marks)

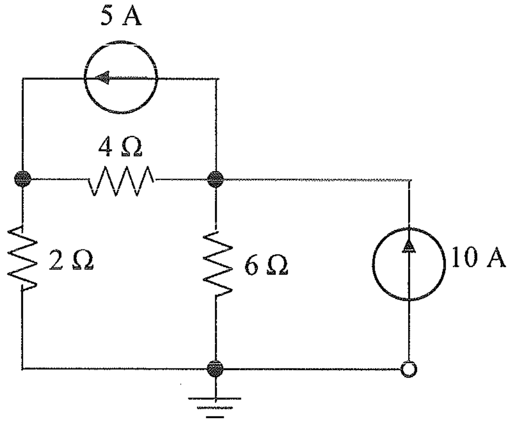

Figure Q1 (b)

c) For the network shown in Figure Q1 (c), find the Thevenin equivalent as viewed from point A and B. (9 marks)

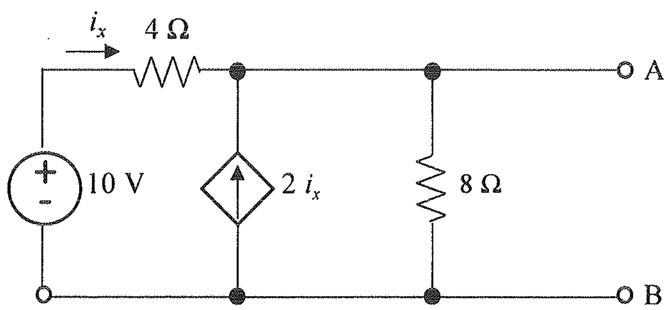

Figure Q1 (c)

[Total: 25 marks]

Question 2

a) Explain the difference between transient response and steady-state response. (5 marks)

b) Find *i(t)* for $t > 0$ in the circuit shown in Figure Q2 (a). Given that the switch is initially closed and it is opened at $t = 0$. (10 marks)

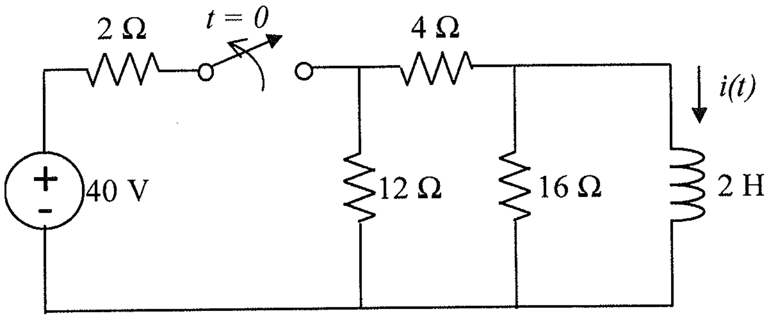

Figure Q2 (a)

c) In a typical digital communication system the signal at the receiving end is applied to a digital-to-analog converter. In order to recover the transmitted analog signal, a smoothing circuit as illustrated in Figure Q2 (b) is used. Determine the voltage across the capacitor, *v(t)*. (10 marks)

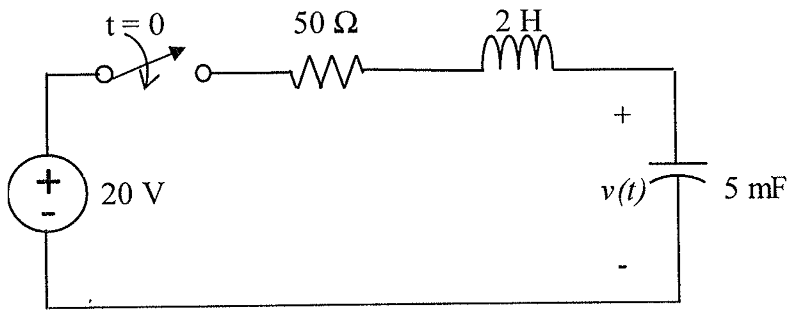

Figure Q2 (b)

[Total: 25 marks]

Question 3

a) Determine the inverse Laplace transform for the following function:

i) $F(s) = \dfrac{10(s+1)(s+2)}{s(s+3)(s+4)}$ (5 marks)

ii) $K(s) = \dfrac{s}{s^2+4s+8}$ (5 marks)

b) For the network shown in Figure Q3 (a), re-draw the circuit in s-domain for $t > 0$ by using Laplace transform method. Note that the switch is opened at $t = 0$. (5 marks)

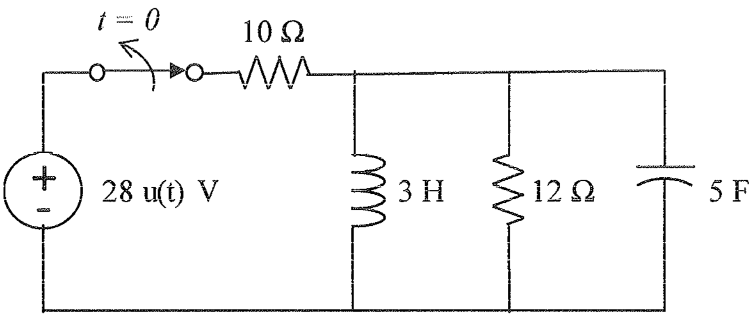

Figure Q3 (a)

c) The use of Laplace transform in circuit analysis facilitates the use of various signal sources such as impulses, step, ramp, exponential and sinusoidal. Assuming zero initial conditions, determine the value of *v(t)* shown in Figure Q3 (b) by using phasor representation method. (10 marks)

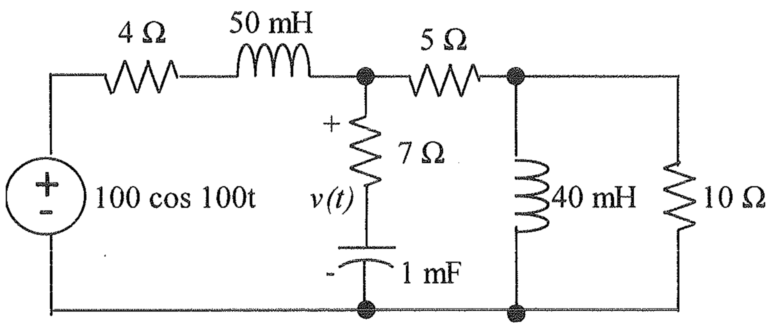

Figure Q3 (b)

[Total: 25 marks]

Question 4

a) Explain the following terms with suitable diagrams:

i) One port network (2 marks)

ii) Two-port network (2 marks)

iii) Impedance parameters (4 marks)

b) Impedance parameters are commonly used in the synthesis of filters, as well as analysis of impedance matching and power distribution network. Determine the impedance parameters for the two-port network shown in Figure Q4 (a). (7 marks)

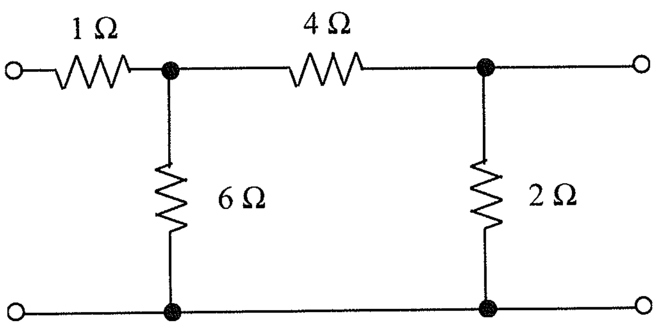

Figure Q4 (a)

c) Transistors are often regarded as two-port, characterized by their hybrid parameters which are listed by the manufacturer. Figure Q4 (b) is the simplified model of a transistor. Obtain the hybrid parameters for this network. (10 marks)

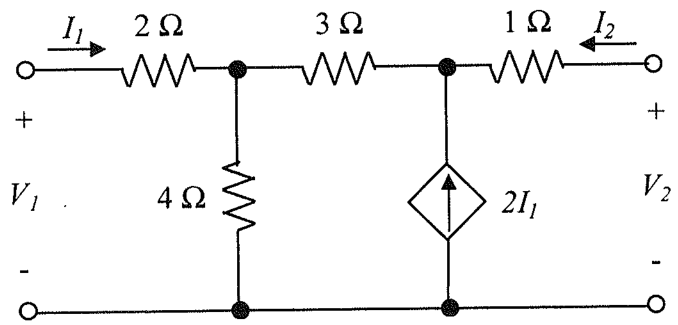

Figure Q4 (b)

[Total: 25 marks]

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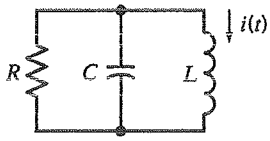
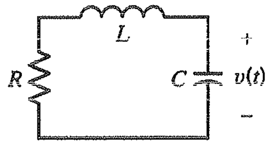
Formula sheet 1

Natural Frequencies of Parallel RLC and Series RLC Circuits

	PARALLEL *RLC*	SERIES *RLC*
Circuit		
Differential equation	$\frac{d^2}{dt^2}i(t) + \frac{1}{RC}\frac{d}{dt}i(t) + \frac{1}{LC}i(t) = 0$	$\frac{d^2}{dt^2}v(t) + \frac{R}{L}\frac{d}{dt}v(t) + \frac{1}{LC}v(t) = 0$
Characteristic equation	$s^2 + \frac{1}{RC}s + \frac{1}{LC} = 0$	$s^2 + \frac{R}{L}s + \frac{1}{LC} = 0$
Damping coefficient, rad/s	$\alpha = \frac{1}{2RC}$	$\alpha = \frac{R}{2L}$
Resonant frequency, rad/s	$\omega_0 = \frac{1}{\sqrt{LC}}$	$\omega_0 = \frac{1}{\sqrt{LC}}$
Damped resonant frequency, rad/s	$\omega_d = \sqrt{\left(\frac{1}{2RC}\right)^2 - \frac{1}{LC}}$	$\omega_d = \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$
Natural frequencies: overdamped case	$s_1, s_2 = -\frac{1}{2RC} \pm \sqrt{\left(\frac{1}{2RC}\right)^2 - \frac{1}{LC}}$ when $R < \frac{1}{2}\sqrt{\frac{L}{C}}$	$s_1, s_2 = -\frac{R}{2L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$ when $R < 2\sqrt{\frac{L}{C}}$
Natural frequencies: critically damped case	$s_1 = s_2 = -\frac{1}{2RC}$ when $R = \frac{1}{2}\sqrt{\frac{L}{C}}$	$s_1 = s_2 = -\frac{R}{2L}$ when $R = 2\sqrt{\frac{L}{C}}$
Natural frequencies: underdamped case	$s_1, s_2 = -\frac{1}{2RC} \pm j\sqrt{\frac{1}{LC} - \left(\frac{1}{2RC}\right)^2}$ when $R > \frac{1}{2}\sqrt{\frac{L}{C}}$	$s_1, s_2 = -\frac{R}{2L} \pm j\sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2}$ when $R > 2\sqrt{\frac{L}{C}}$

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Formula sheet 2

Properties of the Laplace transform.

Property	$f(t)$	$F(s)$
Linearity	$a_1 f_1(t) + a_2 f_2(t)$	$a_1 F_1(s) + a_2 F_2(s)$
Scaling	$f(at)$	$\frac{1}{a} F\left(\frac{s}{a}\right)$
Time shift	$f(t-a)u(t-a)$	$e^{-as} F(s)$
Frequency shift	$e^{-at} f(t)$	$F(s+a)$
Time differentiation	$\frac{df}{dt}$	$sF(s) - f(0^-)$
	$\frac{d^2 f}{dt^2}$	$s^2 F(s) - sf(0^-) - f'(0^-)$
	$\frac{d^3 f}{dt^3}$	$s^3 F(s) - s^2 f(0^-) - sf'(0^-) - f''(0^-)$
	$\frac{d^n f}{dt^n}$	$s^n F(s) - s^{n-1} f(0^-) - s^{n-2} f'(0^-) - \cdots - f^{(n-1)}(0^-)$
Time integration	$\int_0^t f(t)\,dt$	$\frac{1}{s} F(s)$
Frequency differentiation	$tf(t)$	$-\frac{d}{ds} F(s)$
Frequency integration	$\frac{f(t)}{t}$	$\int_s^\infty F(s)\,ds$
Time periodicity	$f(t) = f(t+nT)$	$\frac{F_1(s)}{1-e^{-sT}}$
Initial value	$f(0^+)$	$\lim_{s\to\infty} sF(s)$
Final value	$f(\infty)$	$\lim_{s\to 0} sF(s)$
Convolution	$f_1(t) * f_1(t)$	$F_1(s)F_2(s)$

Laplace transform pairs.

$f(t)$	$F(s)$
$\delta(t)$	1
$u(t)$	$\frac{1}{s}$
e^{-at}	$\frac{1}{s+a}$
t	$\frac{1}{s^2}$
t^n	$\frac{n!}{s^{n+1}}$
te^{-at}	$\frac{1}{(s+a)^2}$
$t^n e^{-at}$	$\frac{n!}{(s+a)^{n+1}}$
$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
$\sin(\omega t + \theta)$	$\frac{s\sin\theta + \omega\cos\theta}{s^2+\omega^2}$
$\cos(\omega t + \theta)$	$\frac{s\cos\theta - \omega\sin\theta}{s^2+\omega^2}$
$e^{-at}\sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$
$e^{-at}\cos \omega t$	$\frac{s+a}{(s+a)^2+\omega^2}$