MACHAKOS UNIVERSITY

University Examinations for 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR SUPPLEMENTARY EXAMINATION FOR
BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 309: ANALOGUE ELECTRONICS II

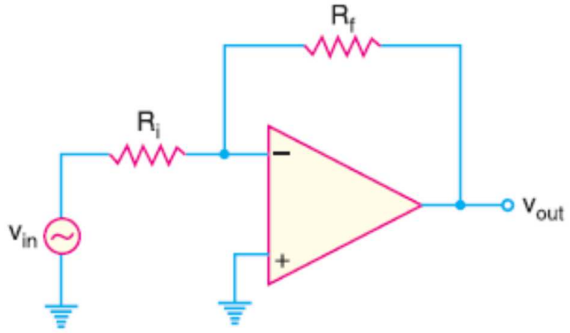
DATE: 25/9/2019 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS.

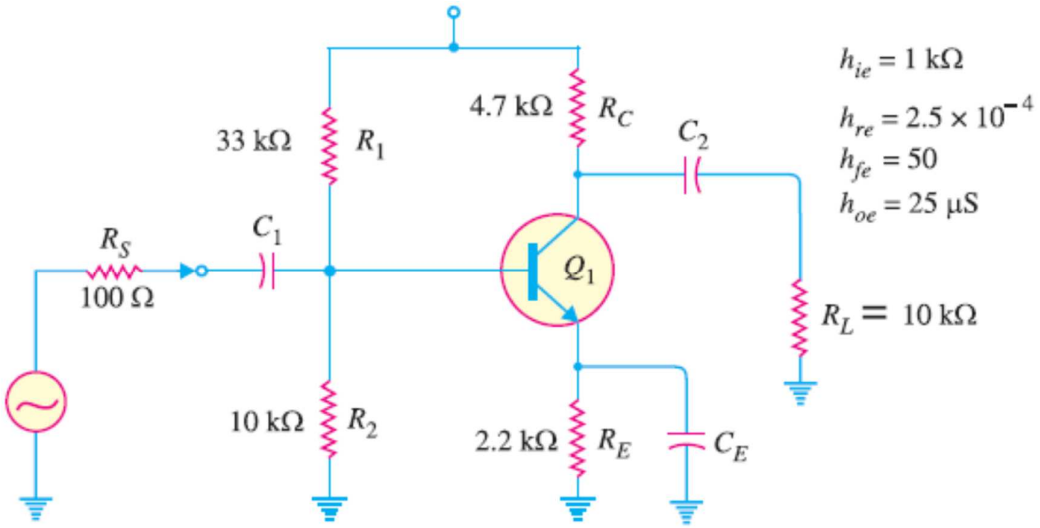
Answer **QUESTION ONE** and **any other TWO.**

QUESTION 1 (30 Marks)

(a) Derive an expression for the voltage gain of the amplifier shown in the figure below. (5mks)



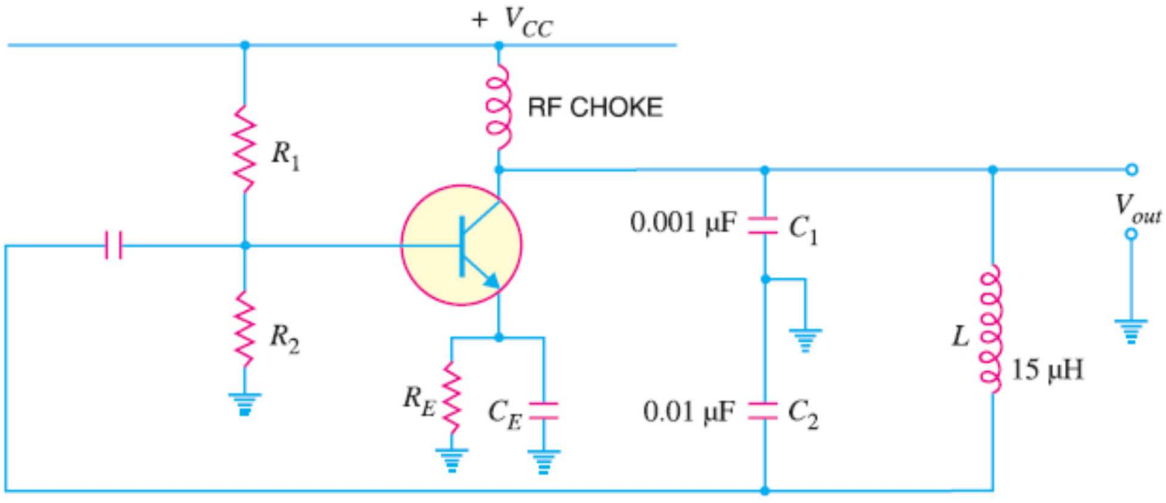
(b) Find the value of current gain for the circuit shown below. The h-parameter values of the transistor are given alongside the figure.. (5mks)



(c) The transistor used in an amplifier has h-parameter values of h_{ie} = 600 Ω to 800Ω and *hfe* = 110 to 140. Using approximate hybrid formula, determine the voltage gain for the circuit. The a.c. collector load, r_L = 460 Ω. (5mks)

(d) The tuned collector oscillator circuit used in the local oscillator of a radio receiver makes use of an LC tuned circuit with $L_1 = 58.6\ \mu H$ and $C_1 = 300\ pF$. Calculate the frequency of oscillations. (5mks)

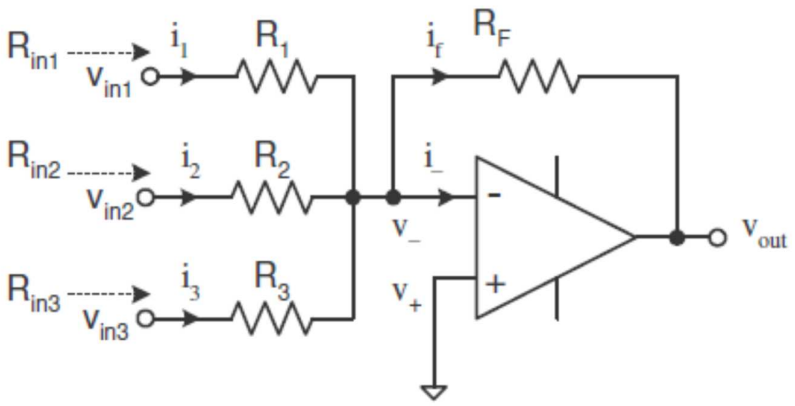
(e) Determine the (i) operating frequency and (ii) feedback fraction for Colpitt's oscillator shown in figure below. (5mks)



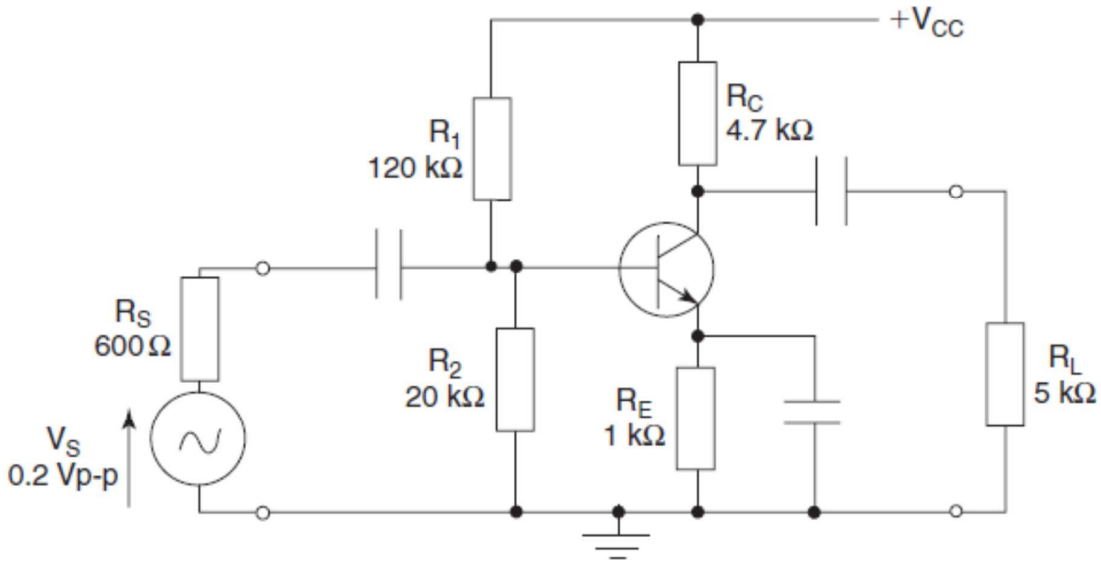
(f) Given a *1 pF* capacitor, choose the inductor values in a Hartley oscillator so that *f = 1 MHz* and the feedback fraction m_v = 0.2. (5mks)

QUESTION 2 (20Marks)

(a) Derive an expression for the output voltage for the OP-AMP circuit below. (4mks)

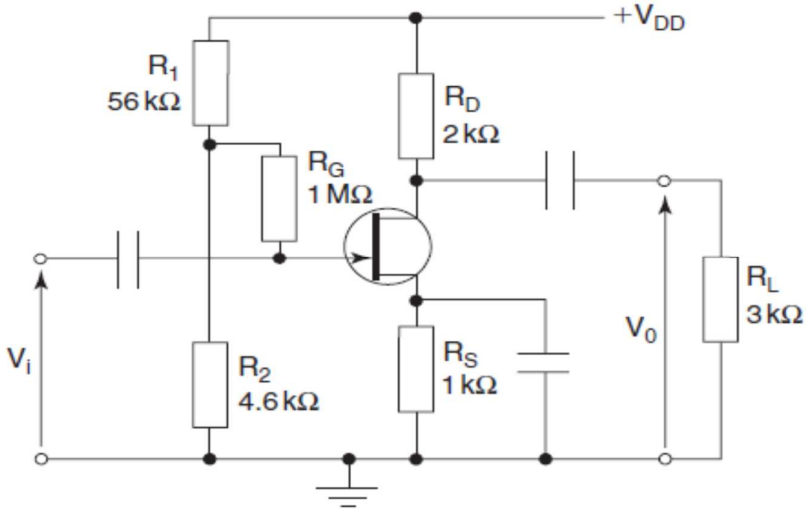


(b) The transistor used in the circuit below has the following h-parameters h_{ie} =2 kΩ ; $h_{oe=}$ 60μS; h_{fe} =100. Calculate (a) the amplifier current gain, (b) the actual power delivered to the external load, and (c) the turns ratio required for a matching transformer in order to maximise the power delivered to the load. (10mks)



$h_{ie} = 2\,\text{k}\Omega; h_{oe} = 60 \times 10^{-6}\,\text{S}; h_{fe} = 100$

(c) The FET used in the amplifier circuit has parameter values as shown below it. Calculate (a) the amplifier voltage gain, and (b) the effective input resistance of the amplifier circuit. (6mks)



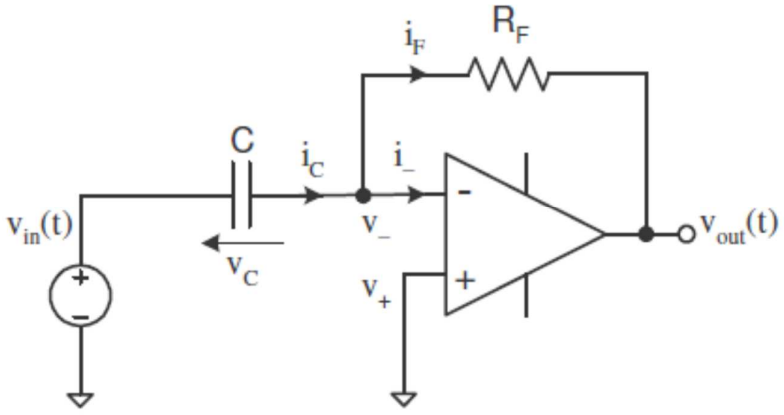
$r_{ds} = 80 \times 10^3\ \Omega;\ g_m = 4 \times 10^{-3}\ \text{S};\ R_L = 3\,\text{k}\Omega$

QUESTION 3 (20Marks)

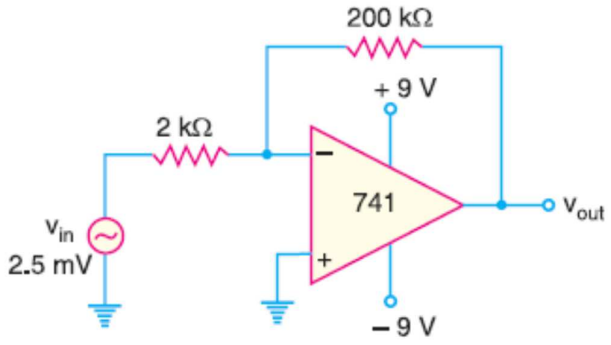
(a) Discuss the terminal properties of an ideal operational amplifier. (4mks)

(b) A **Hartley Oscillator** circuit having two individual inductors of 0.5mH each, are designed to resonate in parallel with a variable capacitor that can be adjusted between 100pF and 500pF. Determine the upper and lower frequencies of oscillation and also the Hartley oscillators bandwidth. (6mks)

(c) For the inverting differentiator circuit shown, derive an expresssion for the output voltage and then sketch the magnitude (V_{out}/V_{in}) (dB) versus frequency plot (log scale). (7mks)

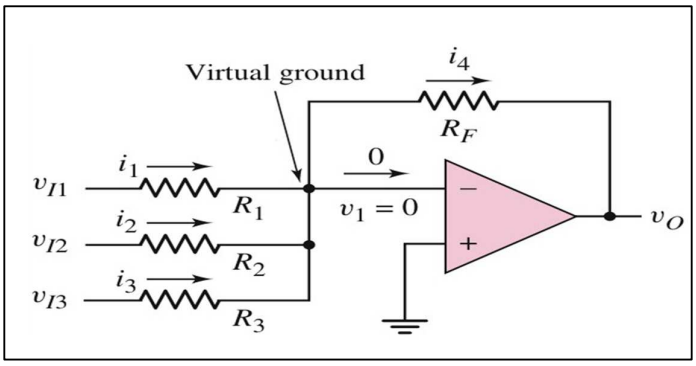


(d) Determine the output voltage for the circuit shown below. (3mks)

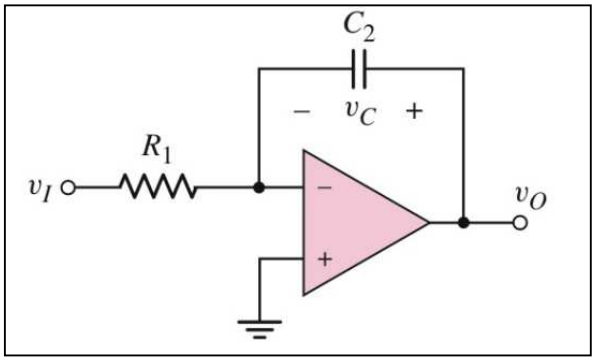


QUESTION 4 (20Marks)

(a) Design a summing amplifier as shown in figure below to produce a specific output signal, such that v_o = 1.25 – 2.5 cos ωt volt. Assume the input signals are v_{I1} = -1.0 V, v_{I2} = 0.5 cosωt volt. Assume the feedback resistance R_F = 10 kΩ. (10mks)

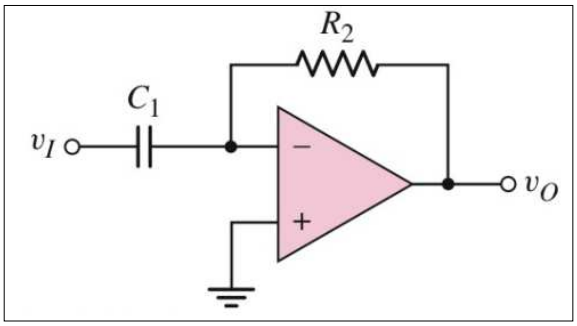


(b) Consider the integrator circuit shown below.



v_C=1.4V at t=0. A step input voltage v_1=-2V is applied at time t=0. Determine the RC time constant necessary that the output voltage reaches +10.2 V at 5ms. (5mks)

(c) Determine the output voltage of the differentiator circuit below if the v_I=3.5cos100πt V and the time constant is 1.5ms. (5mks)



QUESTION 5 (20Marks)

(a) A transistor used in CE arrangement has the following set of h parameters when the d.c. operating point is V_{CE} = *10 volts* and I_C = *1 mA* : h_{ie} = *2000* Ω; h_{oe} =*10–4 mho;* h_{re} = *10–3;* h_{fe} = *50* Determine (i) input impedance (ii) current gain and (iii) voltage gain. The a.c. load seen by the transistor is r_L = *600* Ω. What will be approximate values using reasonable approximations? (6mks)

(b) Explain the principle underlying the working of R-C oscillators. Mention the applications of R-C oscillators. (5mks)

(c) Draw a neat circuit diagram of saw-tooth wave generator using op-amps and describe its operation. Derive an expression for the frequency of the wave. (9mks)