MODULE TITLE : ELECTRONICS

TOPIC TITLE : OSCILLATORS

TUTOR MARKED ASSIGNMENT 3 (v1.1)

NAME..

ADDRESS..

....

....

.... ***HOME TELEPHONE*** ....

EMPLOYER..

....

....

.... ***WORK TELEPHONE*** ....

Student declaration:

I declare that all the work submitted is my own work and that no part of it has been copied from any other source without full acknowledgement and complies with the University's guiding principles as stated in the Regulations Relating To Academic Misconduct.*

Student signature:...

Date: ....

Student code: ....

Email: ....

*http://www.tees.ac.uk/docs/index.cfm?folder=Student%20Regulations&name=Academic%20Regulations

EL - 3 - TMA (v1.1)

Published by Teesside University Open Learning (Engineering)
School of Science & Engineering
Teesside University
Tees Valley, UK
TS1 3BA
+44 (0)1642 342740

IMPORTANT

Before you start please read the following instructions carefully.

1. This assignment forms part of the formal assessment for this module. If you fail to reach the required standard for the assignment then you will be allowed to resubmit but a resubmission will only be eligible for a Pass grade, not a Merit or Distinction.

   You should therefore not submit the assignment until you are reasonably sure that you have completed it successfully. Seek your tutor's advice if unsure.

2. Ensure that you indicate the number of the question you are answering.

3. **Make a copy** of your answers before submitting the assignment.

4. **Complete all details on the front page of this TMA** and return it with the completed assignment including supporting calculations where appropriate. The preferred submission is via your TUOL(E) Blackboard account:

   https://eat.tees.ac.uk

5. Your tutor’s comments on the assignment will be posted on Blackboard.

Assessment Criteria

This assignment relates theory and practice involving positive feedback and oscillators. The assignment forms Element 3 of the module's assessment criteria that covers in part Learning Outcomes 2, 3, 4 and 5 as indicated below.

MODULE LEARNING OUTCOMES
Knowledge and Understanding 1. Demonstrate a detailed knowledge of the sources and effects of noise in electronic systems and components. 2. Demonstrate a detailed knowledge of the effects of types of feedback upon the performance of an amplifier.
Cognitive and Intellectual Skills 3. Apply circuit theory to the analysis of the noise performance of an electronic system and to the analysis of tuned, power and operational amplifiers and oscillator circuits.
Practical and Professional Skills 4. Design, simulate, build and evaluate amplifier and oscillator circuits.
Key Transferable Skills 5. Demonstrate numerical skills applied to the solution of problems relating to the performance of electronic circuits.

PASS	**MERIT** Criteria in excess of the pass grade.	**DISTINCTION** Criteria in excess of the merit grade.
All the requirements defined in the assessment criteria for pass.	The application of appropriate methods and techniques in synthesising and processing complex information and data.	The demonstration of convergent/lateral/ creative thinking in the solution of problems set in more unfamiliar contexts.

1. With reference to the block diagram of FIGURE 1, state the two conditions that must be satisfied to give an oscillatory output.

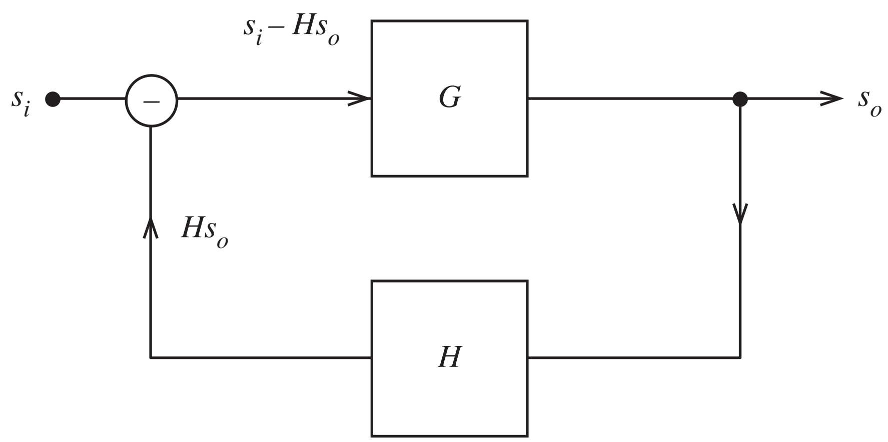


FIG. 1

2. With reference to the block diagram of FIGURE 1, determine the required value of G to give an oscillatory output if $H = -10$ dB.

3. FIGURE 2 shows a public address system.

   (a) It is found that if the microphone is brought into proximity of the loudspeaker, the systems will ‘howl’. Carefully explain, making reference to feedback theory why this is so.

   (b) Suggest two actions that could be adopted to remedy the ‘howling’.

   (c) Measurements show that for a particular arrangement of the equipment and at a particular amplifier setting, the system will howl if 1% of the output power is fed back to the microphone. Estimate the power gain of the P.A. amplifier in decibels.

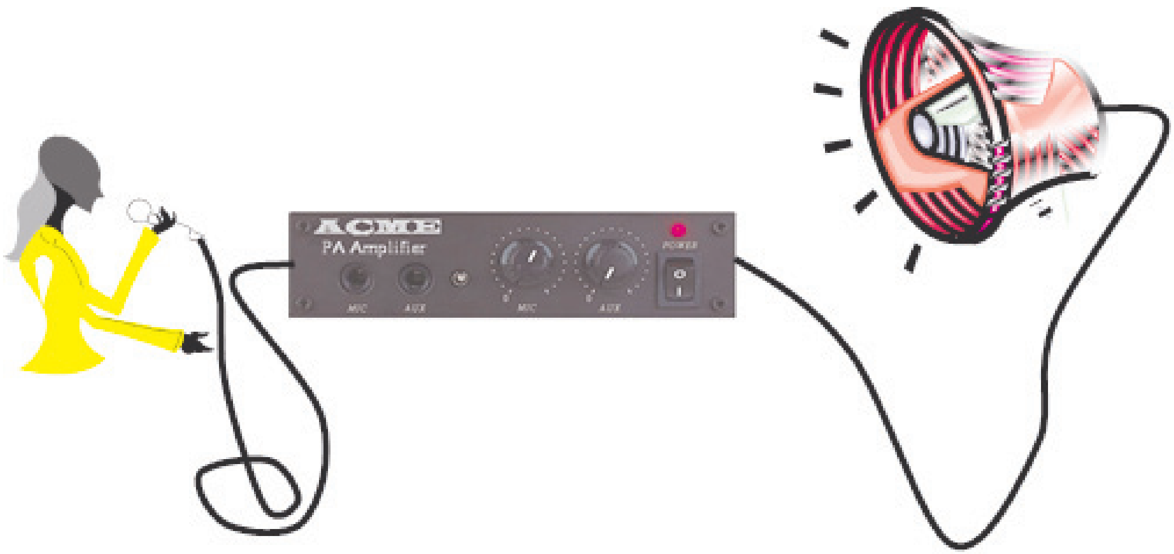


FIG. 2

4. FIGURE 3(a) shows the circuit of an Armstrong oscillator (named after its inventor, the American engineer Edwin Armstrong in 1912). Here a transformer is used to couple the output to the input to give feedback. The transformer has a turns ratio of n:1, where n represents the primary winding.

In this particular circuit the transistor's emitter resistor is bypassed by a large capacitor at a.c. frequencies and its base is biased via the transformer windings.

FIGURE 3(b) represents the a.c. equivalent circuit of the oscillator and (c) its h-parameter equivalent circuit.

(a) Explain the significance of the transformer's dot notation in relation to the operation of the oscillator.

(b) It can be shown that the loop-gain of the oscillator at resonance is given by:

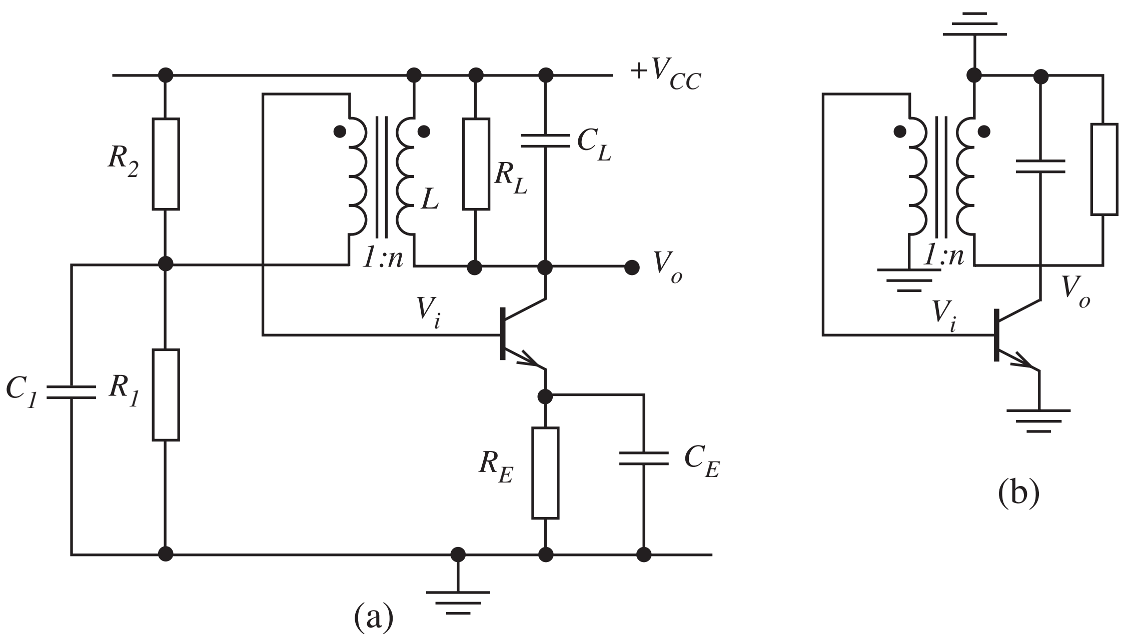
$$\left| G_{V\text{loop gain}} \right| = \frac{1}{n}\left[\frac{h_{\text{fe}}}{h_{\text{ie}}} R'_{\text{L}} \right]$$

where R'_{L} is the effective resistive load on the transistor, i.e.:

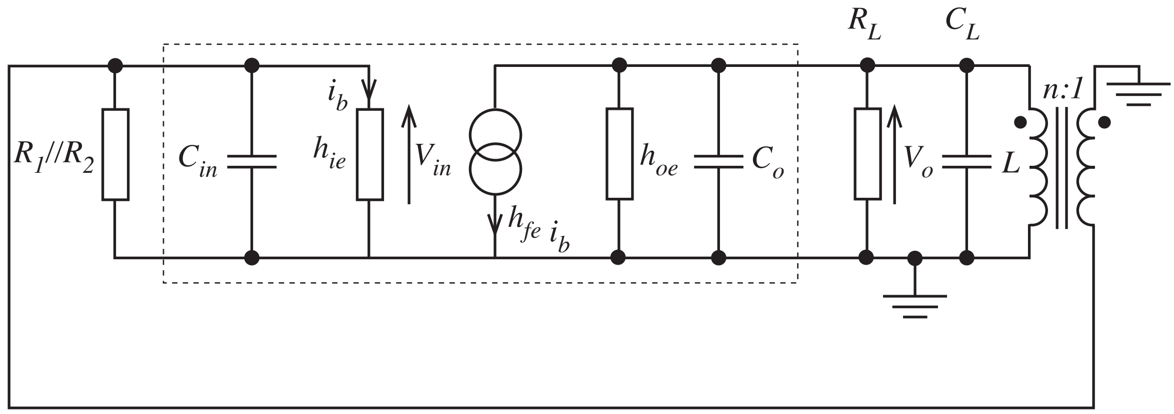
$$R'_{\text{L}} = R_{\text{L}} // h_{oe} // \left[n^2 \left(R_1 // R_2 \right) \right]$$

Estimate the required value of turns-ratio if:

$R_1 = 4.7\ \text{k}\Omega$, $R_2 = 24\ \text{k}\Omega$, $R_{\text{L}} = 2.7\ \text{k}\Omega$, $h_{\text{fe}} = 250$, $h_{\text{oe}} = 10^{-5}\ \text{S}$, $h_{\text{ie}} = 4\ \text{k}\Omega$



FIGS. 3(a) and 3(b)



(c)

FIG. 3(c)

5. FIGURE 4 shows another variation the Armstrong oscillator. A transformer with two secondary windings has been use, one to give feedback and one to give the oscillator's output.

Write a short report [two to three pages] on an investigation into the operation and performance of this circuit[1].

The report should embrace, as far as you are able, the following themes:

(a) Why the output is taken via the transformer rather than directly off the collector of the transistor.

(b) The agreement between the measured and calculated quiescent voltages on the three terminals of the transistor.

[1]The circuit model is available in the module's Learning Materials on Blackboard. In this simulation two extra components, C5/R5, have been added to the left of C2. The added capacitor carries a small initial voltage to act as the necessary noise required to 'kick start' the oscillator. The default run time is from 100 to 102 milliseconds. The transformer has been formed from three mutually coupled inductors, rather than using the transformer model. This has been done because the parameter 'inductance' can be swept for an inductor in an a.c. analysis. This facility is not available in the transformer model.

(c) The agreement between the measured and calculated frequency of oscillation.

(d) The shape of the output waveform in the first 10 milliseconds of start-up.

(e) The given L1:L2 ratio is not necessarily the optimum value to give a good sinusoidal output. [A Fourier probe on the output will give a spectral response]. Try to devise an experiment to find the optimum ratio*. Express the ratio as a *turns* ratio.

The report should include copies of any graphical responses produced in the investigation.

*This can be done by performing an AC sweep on the inductance parameter L2. However a sweep cannot be performed without a voltage source in the circuit. For the purposes of this analysis a small voltage source can be inserted into the feedback loop as shown in the second version of the circuit on Blackboard.

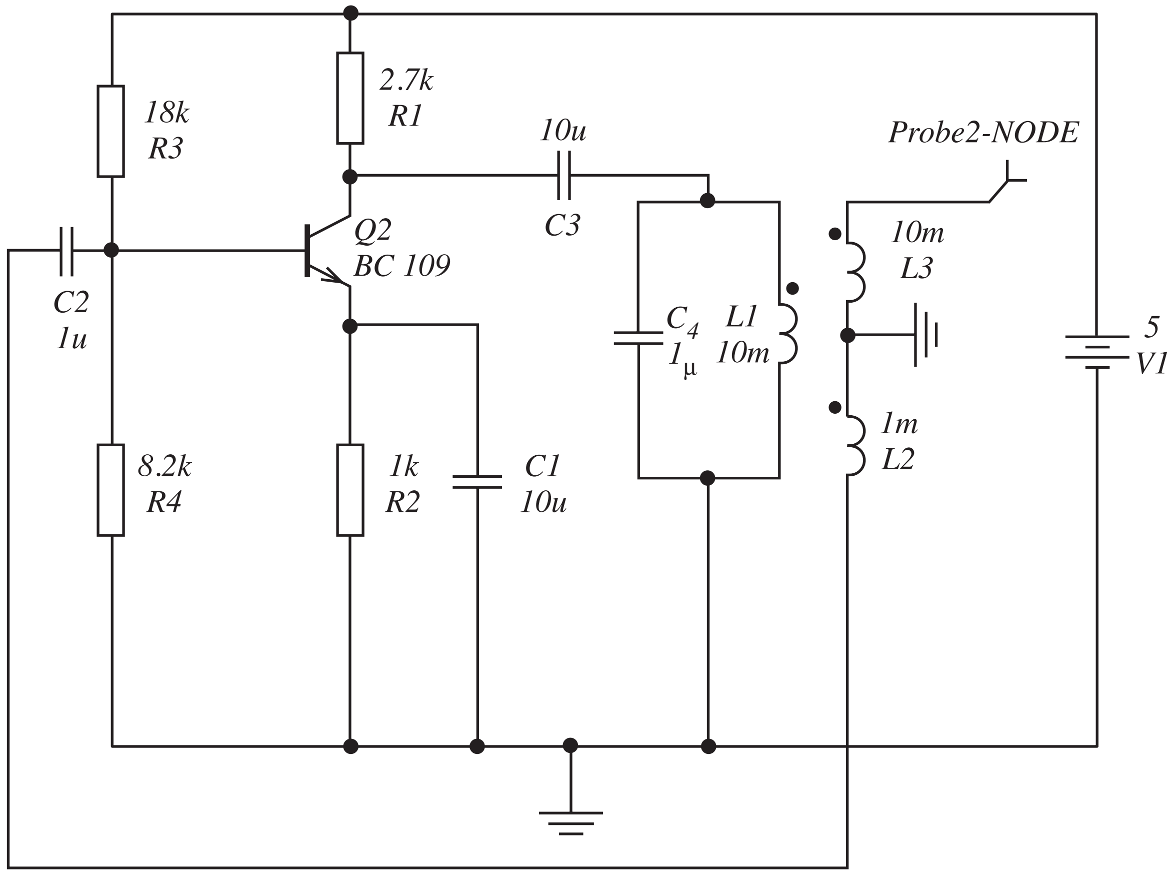

18k
R3
2.7k
R1
10u
C3
Probe2-NODE
Q2
BC 109
C2
1u
10m
L3
C4
1μ
L1
10m
5
V1
1m
L2
8.2k
R4
1k
R2
C1
10u

FIG. 4

Question No.	