COLLEGE OF ENGINEERING, SCIENCE & TECHNOLOGY (CEST)

SCHOOL OF ELECTRICAL & ELECTRONICS ENGINEERING

TRADE DIPLOMA IN ELECTRICAL ENGINEERING

TDEEN 3

EEE503 ANALOG ELECTRONICS 2B

FINAL EXAMINATION – SEMESTER I, 2014

DURATION OF EXAM–2 HOURS

DAY/DATE:

INSTRUCTIONS TO STUDENTS

1. You are allowed 10 minutes Extra reading time during which you are NOT to write.

2. Begin each answer on a fresh page and use both sides of the sheet.

3. Write your candidate-number at the top of each attached sheet

4. Insert all written foolscaps, graph paper, drawing paper, etc. in their correct sequence and secure with string

5. For all sheets of paper on which rough/draft work has been done, cross it though and you MUST ATTACH to your answer scripts.

6. Write clearly the number(s) of the question(s) attempted on the top of each sheet.

7. ***SECTION A-ANSWER ALL QUESTIONS. SECTION B-ANSWER ONLY 4 QUESTIONS***

8. Show all workings where necessary.

9. Do not use programmable calculators, especially the ones that does the conversions of number systems.

10. ***ALWAYS CHECK YOUR WORK BEFORE YOU LEAVE THE ROOM****!*

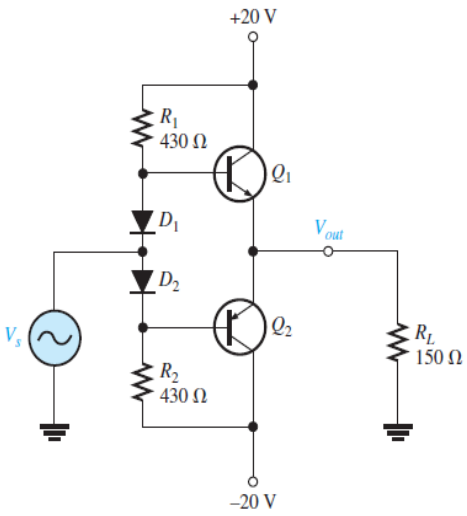
SECTION A–MULTIPLE CHOICE (20 MARKS)

1. An integrated circuit (IC) op-amp has
A. Two inputs and two outputs
B. One input and one output
C. Two inputs and one output
D. None of the above

2. If the harmonic distortion components for an output signal has a fundamental amplitude of 2.5 V, second harmonic amplitude of 0.25 V, third harmonic amplitude of 0.1 V, and fourth harmonic amplitude of 0.05 V what will be its total harmonic distortion?
A. 15%
B. 2.5%
C. 0.45
D. 10.95%

3. If Aol = 3500 and A*cm* = 0.35, the CMRR is
A. 1225
B. 10,000
C. 80 dB
D. answers (b) and (c)

Please refer to the circuit given below to answer the next 2 questions.



4. The ideal maximum peak voltage for the above circuit is
A. 10V
B. 20V
C. 40V
D. None of the above

5. The ideal maximum peak current is

A. 0.067 A
B. 0.27 A
C. 0.13 A
D. None of the above

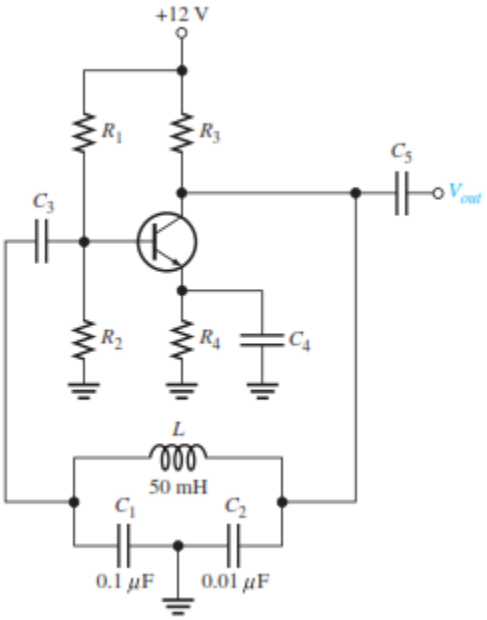
6. The bandwidth of an ac amplifier having a lower critical frequency of 1 kHz and an upper critical frequency of 10kHz is

A. 1 kHz
B. 9 kHz
C. 10 kHz
D. 11 kHz

7. The purpose of offset nulling is to

A. reduce the gain
B. increase the gain
C. zero the output error voltage
D. none of the above

8. Determine the frequency for the oscillator shown below. Assume there is negligible loading on the feedback circuit and that its Q is greater than 10.



A. 7.4 MHz
B. 7.46 kHz
C. 6 kHz
D. None of the above

9. Bias current compensation
A. reduces gain
B. reduces output error voltage
C. increases bandwidth
D. has no effect

10. An amplifier that operates in the linear region at all times is
A. Class A
B. Class AB
C. Class B
D. Class C

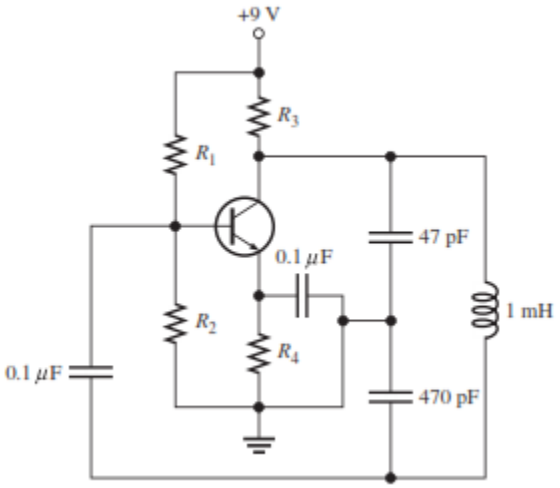
11. If V_{AK} = 15 V and the forward break-over voltage is 50 V, by how much V_{AK} must be increased to switch the diode into the forward-conduction region?
A. 15 V
B. 50 V
C. 35 V
D. 65 V

12. For maximum output, a class A power amplifier must maintain a value of quiescent current that is
A. one-half the peak load current
B. twice the peak load current
C. at least as large as the peak load current
D. just above the cutoff value

13. Crossover distortion is a problem for
A. class A amplifiers
B. class AB amplifiers
C. class B amplifiers
D. all of the above

14. An output waveform displayed on an oscilloscope provides the following measurements: V_{CEmin} = 1 V, V_{CEmax} = 22 V, V_{CEQ} = 12 V. The second harmonic distortion will be
A. 3%
B. 1%
C. 21%
D. 2.4%

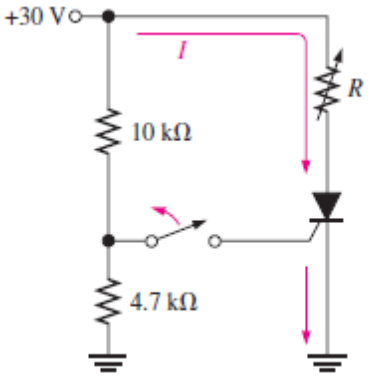
15. What will be the required gain of the amplifier for the given in order to have sustained oscillation.



A. 1
B. 3
C. 1/29
D. 10

16. The quality factor 'Q' is equal to
A. XL/R
B. L/CR
C. fr/BW
D. Both A and C

17. To what value must the variable resistor be adjusted in the figure shown below in order to turn the SCR off? Assume IH = 10 mA and VAK = 0.7 V.

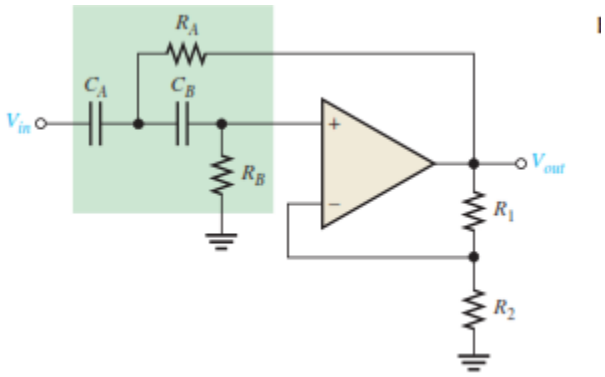


A. 3 Ω
B. 2.93 kΩ
C. 4.7 kΩ

D. 14.7 kΩ

18. Electronic noise is caused by unpredictable motion of electrical carriers that give rise to three different types of noises. They are:

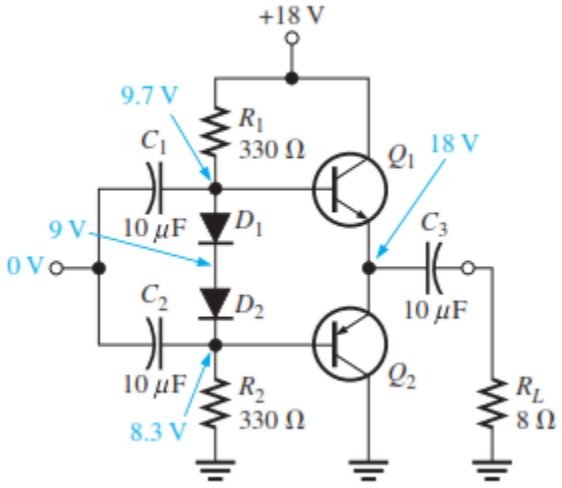
A. thermal noise, burst noise, pink noise
B. thermal noise, pink noise, 1/f noise
C. solar noise, thermal noise, atmospheric noise
D. burst noise, pink noise and 1/f noise



19. The above circuit is a

A. 2 pole Low pass filter
B. 2 pole band pass filter
C. 2nd order high pass filter
D. 2nd order Band stop filter

20. What is the possible fault, if any, for the given circuit on the indicated dc voltage measurements?



A. No dc supply voltage or R1 open
B. Diode D2 is open

C. Q1 shorted from collector to emitter
D. Circuit is OK

SECTION B-ANSWER ONLY 4 QUESTIONS (80 MARKS)

QUESTION 1 **(20 MARKS)**

A. With the aid of diagrams or formulas briefly explain the following:

i. The effect negative feedback on the input bias current in an inverting amplifier (2 marks)

ii. Input offset voltage compensation (2 marks)

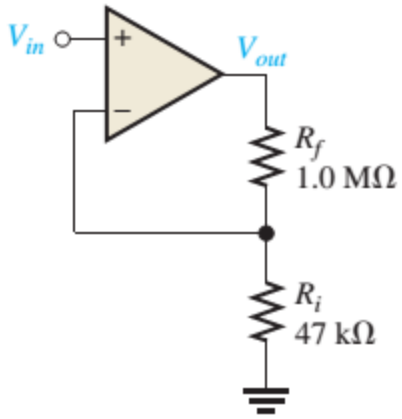
iii. Effect of negative feedback on bandwidth (2 marks)

B. Two output waveforms for a non-inverting amplifier circuits are shown below. Briefly explain why the amplifier is producing these output waveforms and support your answer mathematically.
(4 marks)

(a)

(b)

C. If a signal voltage of 10 mV rms is applied to the given amplifier, what will be the output voltage and its phase relationship with input? (2 marks)



D. A certain op-amp has three internal amplifier stages with midrange gains of 30 dB, 40 dB, and 20 dB. Each stage also has a critical frequency associated with it as follows: f_{c1} = 600 Hz, f_{c2} = 50 kHz, and f_{c3} = 200 kHz.

i. What is the midrange open-loop gain of the op-amp, expressed in dB? (1 mark)

ii. What is the total phase shift through the amplifier, including inversion, when the signal frequency is 10 kHz? (5 marks)

E. Given that $f_{c(ol)}$ = 750 Hz, A_{ol} = 89 dB, and $f_{c(cl)}$=5.5kHz, determine the closed-loop gain in decibels. (2 marks)

QUESTION 2 **(20 MARKS)**

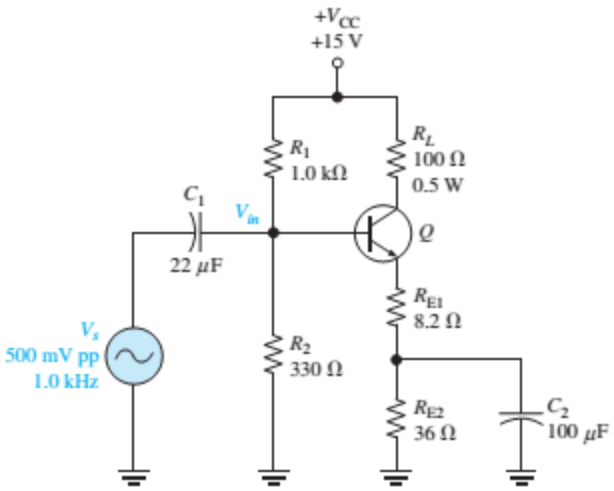
A.

i. A lot of internally generated heat is dissipated in power amplifiers. In which junction of a BJT power transistor is most heat generated and how is this heat removed? (2 mark)

ii. What is thermal resistance? (1 mark)

iii. What are the two factors that determine the operating temperature of a transistor? (2 marks)

iv. The metal tag of a power transistor operating at 2.2 W is at 90°C. It is bolted to a heat sink and the ambient temperature (inside the circuit enclosure) is 35° C. What is the thermal resistance of the heat sink? (2 marks)



B. The figure above shows a CE power amplifier in which the collector resistor serves also as the load resistor. Assume $\beta_{DC} = \beta_{ac} = 100$. Determine the following:

i. DC Q-point (I_{CQ} and V_{CEQ}) (2 marks)

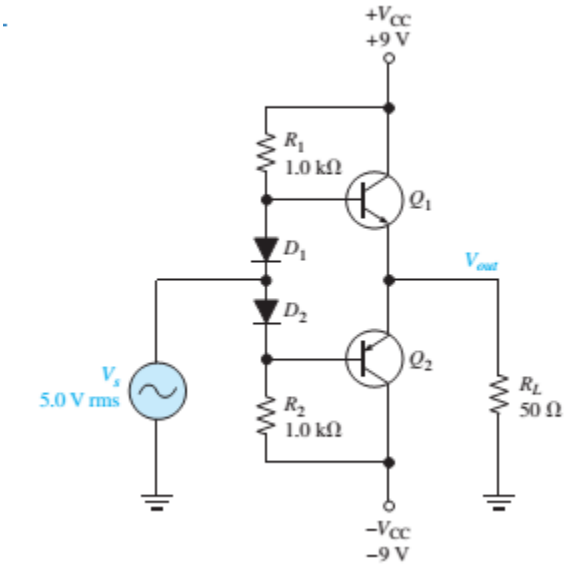
ii. Voltage gain and the power gain. (2 marks)

iii. The power dissipated in the transistor with no load (1 marks)

iv. The signal power in the load with a 500 mV input (2 marks)

C. Refer to the class AB amplifier shown below, operating with a single power supply and determine the dc parameters $V_{B(Q1)}$, $V_{B(Q2)}$, V_E, I_{CQ}, $V_{CEQ(Q1)}$, $V_{CEQ(Q2)}$.

(6 marks)

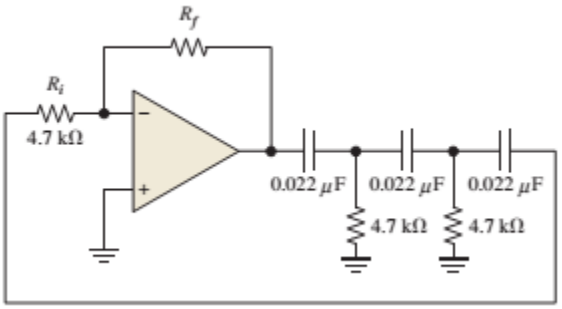


QUESTION 3 **(20 MARKS)**

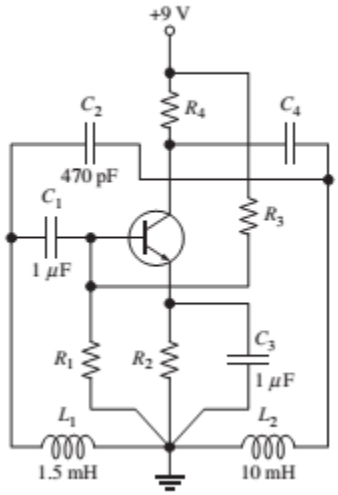
A. Given R1 = 2R2 prove mathematically that the closed loop gain A*cl* of the wien-bridge oscillator is 3. (1.5 marks)

B. With the aid of diagrams, explain the start-up conditions for oscillations. Assume A*cl* = 3. (5 marks)

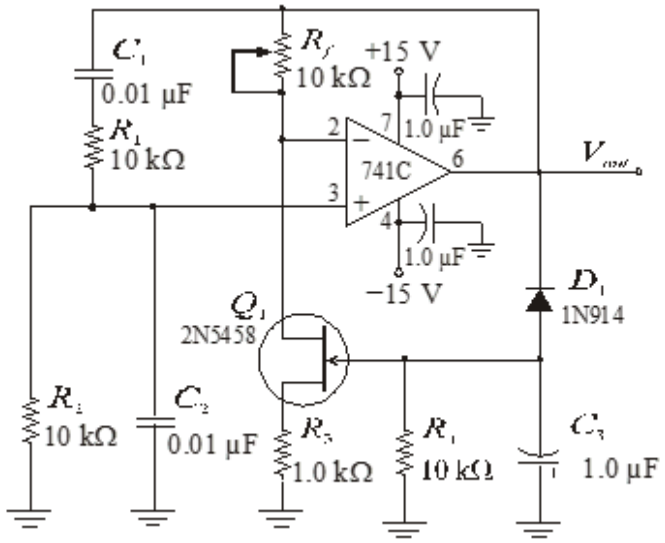
C. What value of Rf is required in the circuit? Determine the value of fr. (4 marks)



D. Calculate the frequency of oscillation for the oscillator shown below and identify the type of oscillator. Assume Q > 10. (2.5 marks)



E. Assume the Wien Bridge oscillator shown below is not oscillating. The power supply voltages are okay, so you want to check that the op-amp is working and that the negative feedback, including the FET, is okay. How could you do this? (4 marks)



F. In an astable 555 configuration, the external resistor R_1 = 3.3 kΩ. What must R_2 equal to produce a duty cycle of 75 percent? (3 marks)

QUESTION 4 **(20 MARKS)**

A. A signal has an rms value of v*s* = 2.4V. The rms noise level v*n* is 7nV. Calculate the signal-to-noise ratio. (1 marks)

B. Calculate the harmonic distortion components for an output signal having fundamental amplitude of 2.5 V, second harmonic amplitude of 0.25 V, third harmonic amplitude of 0.1 V, and fourth harmonic amplitude of 0.05 V. With I1 = 5A and Rc = 8Ω, calculate the total harmonic distortion, fundamental power component and total power. (4 marks)

C. Briefly explain the 3 advantages of a tuned amplifier. (6 marks)

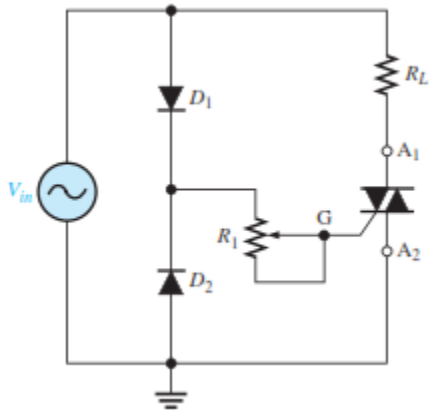
D. Given that the line current for a tuned amplifier is $I = I_L \cos \phi_L$, show that Zr = L/CR. (4 marks)

E. A parallel resonant circuit has a capacitor of 250pF in one branch and inductance of 1.25mH plus a resistance of 10Ω in the parallel branch. Find:

i. Resonant frequency (1 mark)
ii. Impedance of the circuit at resonance (2 marks)
iii. Q-factor of the circuit. (2 marks)

QUESTION 5 **(20 MARKS)**

A.



The above shows the application of the triac in controlling power to the load. Briefly explain the operation of the circuit and draw its input and output waveforms.
(3 marks)

B. An SCR half-wave rectifier has a forward breakdown voltage of 150 V when a gate current of 1 mA flows in the gate circuit. If a sinusoidal voltage of 400 V peak is applied, find:

i. firing angle (1 mark)
ii. average output voltage (1 mark)
iii. average current for a load resistance of 200Ω (1 mark)
iv. power output (1 mark)

Assume that the gate current is 1mA throughout and the forward breakdown voltage is more than 400 V when I=1mA.

C. Draw the basic construction of a cathode ray oscilloscope and label the different parts.
(9 marks)

D. Briefly explain the operation cathode ray oscilloscope. (4 marks)