UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION, 2008

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

TITLE OF PAPER: ELECTRONIC SYSTEM DESIGN

COURSE CODE: E330

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. **There are four questions in this paper. Answer Question ONE and any other TWO questions.**
2. **Question one carries 60 marks while the other questions each carry 20 marks.**
3. **If you think not enough data has been given in any question you may assume any reasonable values.**
4. **E12 Range: 10 12 15 18 22 27 33 39 47 56 68 82**

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THIS PAPER CONTAINS SIX (6) PAGES INCLUDING THIS PAGE

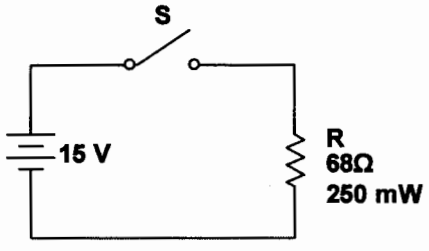
QUESTION ONE (COMPULSORY) ***(60 marks)***

(a) Explain, giving relevant expressions, the purpose of the following:

i. A dielectric material in a capacitor. *(4 marks)*

ii. A ferrite core in an inductor. *(4 marks)*

(b) A student connected the following circuit and switched it on. Explain the subsequent behaviour of the circuit. What advise would you give this student when making such a circuit? *(5 marks).*



(c) Two electronic system blocks A and B with output resistance R_o and input resistance R_{in} respectively are connected together in cascade. What would be the requirements for R_{in} and R_o in each of the following cases:

(i) Maximum power transfer from A to B? *(1 mark)*

(ii) Maximum voltage transfer from A to B? *(2 marks)*

(iii) Maximum current transfer from A to B? *(2 marks)*

(d) Consider an LC parallel resonant circuit, and

(i) Derive its resonant frequency, *(4 marks)*

(ii) Explain what happens to its reactance when the signal frequency goes below and above the resonance frequency. *(2 marks)*

(e) Why is it important to know the resonance frequency of a capacitor? How would you use this parameter in electronic circuit design? *(5 marks)*

(f) A fixed frequency oscillator gives a frequency of 10.7 MHz at 23°C and has a frequency which varies at most by 5 ppm/°C. In the worst case, what would be the oscillator frequency at 60°C? *(5 marks)*

(g) The coil of a solenoid is used as an inductor by connected it to an a.c. voltage source. Explain what happens to the current in the coil as the solenoid is moved away from the coil. *(3 marks)*

(h) How can an inductive coil be used to block high frequency current? *(2 marks)*

(i) A capacitor is fully charged to 100 V and then discharged through a resistor from time $t = 0$ s. After 30 s the voltage across the capacitor has fallen to 5 V. At what time was the voltage across the capacitor equal to 30 V? *(5 marks)*

(j) A transformer is rated at 60 VA, 240V/30V. What ratings of fuses would you use to protect its primary and secondary windings? *(5 marks)*

(k) i. What is the relationship between a system's failure rate and its MTBF? *(1 mark)*

ii. Name 5 factors which affect an equipment's MTTR. *(5 marks)*

iii. A printer has a reliability of 98% for 2,000 hours of operation. Calculate the probability that this printer will be operating after 5,000 hours of operation. *(5 marks)*

QUESTION TWO ***(20 marks)***

A coaxial cable has a characteristic impedance of 50Ω and a dielectric of $\varepsilon_r = 2.2$.

(a) Calculate the velocity of signal in the cable. *(2 marks)*

(b) A narrow pulse sent through the cable with the other end open circuited, returns back after 0.2 μs. Calculate the length of the cable. *(6 marks)*

(c) A 45-MHz signal is sent with zero phase from one end of the cable. With what phase will it arrive at the other end? *(6 marks)*

(d) The cable is fed from a source of 30 Ω impedance which generates a narrow 1 V amplitude isolated pulse, and the other end is terminated in a 130 Ω load. Calculate the amplitude level of the pulse after two reflections. Assume that the cable is lossless. *(6 marks)*

QUESTION THREE *(20 marks)*

The circuit shown below is found in many oscilloscope probes. It is designed to attenuate the incoming signals while increasing the effective input impedance of the scope.

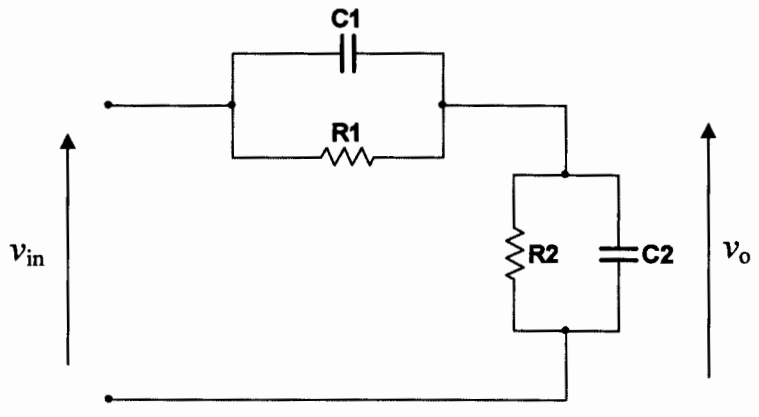
(a) Find and expression for the ratio of the voltages v_o/v_{in} in terms of ω, R's and C's. *(8 marks)*

(b) Under what condition will the ratio v_o/v_{in} be independent of frequency? *(2 marks)*

(c) What will be the ratio v_o/v_{in} under the condition in (b)? *(2 marks)*

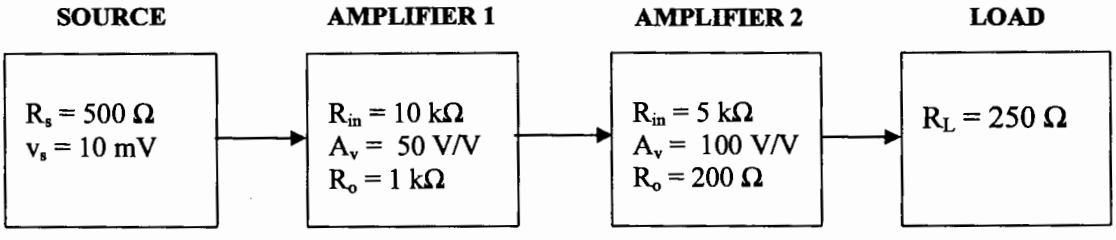
(d) What is the expression for input impedance of the circuit at low frequencies? *(3 marks)*

(e) Given that $R_2 = 1\ M\Omega$ and $C_2 = 30\ pF$, calculate suitable values of R_1 and C_1 so that the input impedance of the circuit becomes $10\ M\Omega$. *(5 marks)*



QUESTION FOUR *(20 marks)*

Consider the system blocks shown below. The parameters of each block are shown inside the block



(a) Determine the voltage appearing at the load. *(8 marks)*

(b) If the positions of the two amplifying blocks are interchanged, find the voltage appearing at the load. *(7 marks)*

(c) If it is required that the voltage appearing at the load be 10 V, show how you achieve this by adding one resistor to the system. *(5 marks)*