UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
ONLINE
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	ELECTROMAGNETIC COMPATIBILITY
COURSE CODE	:	BEB 41703
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY 2021
DURATION	:	4 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS OPEN BOOK EXAMINATION

THIS QUESTION PAPER CONSISTS OF **SEVENT (7)** PAGES

Q1 (a) Elaborate on each of the following statements:

(i) Electrostatic charges on a person can cause fire at a petrol station if he or she does not take extra precautions.

(4 marks)

(ii) An OATS is alternative EMC facilities as compare with TEM and GTEM cell. However, it has many disadvantages as compare with Semi-Anechoic Chamber and Reverberation Chamber.

(4 marks)

(iii) As an engineer, you need to ensure that an equipment and system for fix installation comply with EMC standard in intended environment. IEC just published a new standard and has been adopted by British Standard (BSI). However, OJEU still using previous standard that already withdrawn in IEC.

(8 marks)

(b) Most electronic circuits nowadays operate at high frequency. Hence the importance of studying the behavior of circuit elements when frequency increases to ensure that operation works as designed.

(i) What happens to the resistance of conductors when the frequency increases? Briefly explain why.

(4 marks)

(ii) Explain what happened to the wire conductor as frequency increase related to the skin effect (δ).

(5 marks)

Q2 (a) Common-mode currents can generally produce higher radiated emissions than differential-mode currents. Justify this statement by using illustration and analytical formulation.

(4 marks)

(b) Radiated emission (RE) test is one of the important tests for EMC compliance. Nowadays, an automated system is used to perform the RE test to control the antenna, turntable and other instruments. Present a description in the form of a flowchart on how the RE test is performed to obtain a list consisting of quasi-peak electric fields measurement.

(8 marks)

(c) The radiated emissions of a cable are being measured as shown in **Figure Q2(c)** at 200 MHz. The antenna factor at 200 MHz is 12 dB and the antenna is oriented parallel to and in the plane of the wires. The antenna is connected to a spectrum analyzer using a 3m length of RG58U coaxial cable wi h 0.25dB/m loss at 200 MHz.

(i) Calculate the magnitude of the radiated electric field due to the differential-mode component and due to the common-mode component at the antenna.

(8 marks)

(ii) Will the emission in **Q2(c)(i)** pass the EN 55022 Class B test?

(2 marks)

(iii) Indicate the magnitude of the voltage measured by the spectrum analyzer.

(3 marks)

Q3 (a) You are an EMC test-engineer working in a company producing DVD players. The R&D department has come up with a new design of the player which must be marketed to USA in 3 months time. Your main responsibility is to ensure that the product pass all the EMC tests within the stipulated time frame.

(i) List as many as possible the best practices in system design of the DVD player to ensure EMC compliance.

(5 marks)

(ii) Describe all the EMC tests that should be conducted on the DVD player.

(4 marks)

(iii) If it was found that the SMPS radiated emission exceeds the permitted limit at 50 MHz. Recommend two (2) EMC best practices in the design of the SMPS circuit in order to overcome this situation

(6 marks)

(b) Line Impedance Stabilization Network (LISN) is used to measure the noise currents that exit the product's AC power cord conductor for verification of compliance with FCC and CISPR 22 from 150 kHz to 30 MHz.

(i) Explain briefly why LISN is needed for a conducted emission measurement.

(6 marks)

(ii) Illustrate the use of a LISN in the measurement of conducted emissions of a product.

(4 marks)

4. (a) You are required to provide credible facts (equations and figures) to support the following statements on electromagnetic shielding.

(i) It is difficult to shield low-frequency magnetic field.

(2 marks)

(ii) Apertures considerably reduce the effectiveness of a shield.

(3 marks)

(b) A barrier made of copper ($\mu_r = 1$, $\varepsilon_r = 1$, $\sigma = 5.8 \times 10^7$ S/m) of thickness 0.1 mm is to be used as an enclosure to shield a digital circuit at 1 MHz. Calculate the skin depth and total loss (reflection loss + absorption loss + multiple reflection loss) of the barrier (in dB). Assume that the field incident on the barrier is a far-field source and the effect of openings on the enclosure can be neglected.

(10 marks)

(c) A noisy circuit is connected to AC power mains. The AC power mains could be modeled as a AC power source with a source resistance of 25 Ω. The noisy circuit could be modeled as a noisy voltage source with a source resistance of 5 Ω. To attenuate the noise from the noisy circuit to the AC power mains, a lowpass filter is added between the AC mains and the noisy circuit. Determine the filter attenuation characteristic using:

(i) 0.1 μF shunt capacitor as lowpass filter

(5 marks)

(ii) 1 mH series inductor as lowpass filter

(5 marks)

(Note: You may use the Impedance Graph to assist in **Figure Q4(c)**)

END OF QUESTIONS

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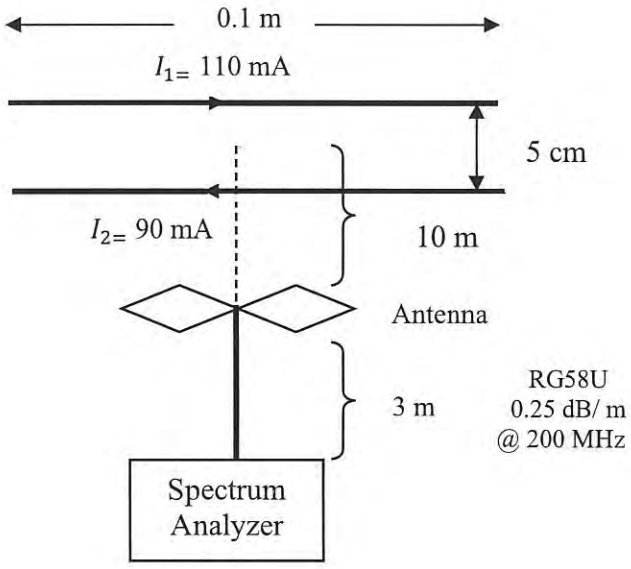

FIGURE Q2 (c)

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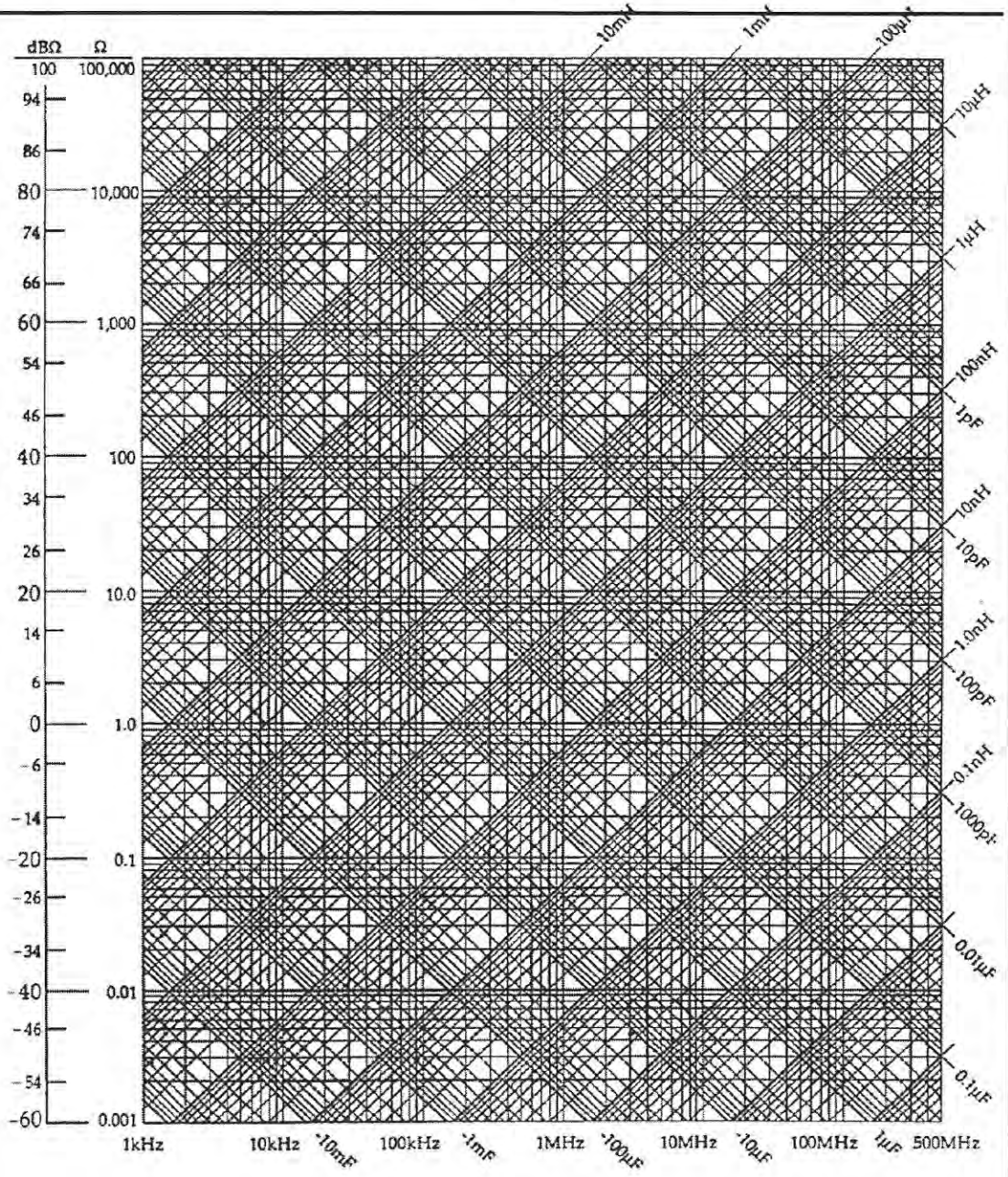

FIGURE Q4 (c)