



Beijing-Dublin International College



SEMESTER 1 FINAL EXAMINATION - 2021/2022

BDIC3018J Electromagnetics 2

MODULE COORDINATOR: Xiaoli Li

Time Allowed: 95 minutes

Instructions for Candidates

The full mark of this exam paper is **60**.

BJUT Student ID: _____ **UCD Student ID:** _____

I have read and clearly understand the Examination Rules of both Beijing University of Technology and University College Dublin. I am aware of the Punishment for Violating the Rules of Beijing University of Technology and/or University College Dublin. I hereby promise to abide by the relevant rules and regulations by not giving or receiving any help during the exam. If caught violating the rules, I accept the punishment thereof.

Honesty Pledge: _____ **(Signature)**

Instructions for Invigilators

This is a closed-book examination.

Candidates are allowed to use non-programmable calculators.

Final Exam

Note: In this paper, let $\pi = 3.14$, and keep two digits after decimal point,
for example, take 1.26 for 1.257.

Please write all the answers on the answer sheet.

Part 1. Single-Choice. There are 8 problems with total marks of 16.

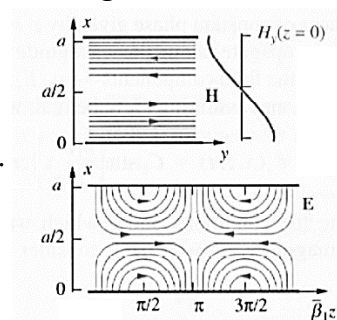
1.1 Choose the statement that is absolutely correct from the options below _____

- A. No current can be generated in vacuum
- B. In a steady magnetic field, no emf can be generated in a wire loop
- C. The displacement current induced in conductors can result in the loss of Joule Heat
- D. For a parallel-plate capacitor, some displacement current can be induced between the two plates during the charging process

1.2 Figure 1 shows the field configurations of a guided wave, named as ____ mode, propagating along +z direction in a parallel-plate waveguide.

- A. TE_1
- B. TM_1
- C. TM_2
- D. TEM

Figure 1.



1.3 For a uniform plane wave normally incident from free space onto a planar interface with a perfect conductor, the reflection coefficient is _____

- A. 0
- B. 1
- C. -1
- D. depends on the frequency of the wave

1.4 For a lossless transmission line, the characteristic impedance depends on _____

- A. The ratio L/C
- B. The angular frequency ω
- C. The ratio L/C and the angular frequency ω
- D. None of these

1.5 If a Gaussian pulse is propagated through a lossless but dispersive channel _____

- A. The pulse becomes narrower
- B. The pulse broadens out
- C. The pulse increases in amplitude
- D. The pulse remains constant in amplitude

1.6 Assume the Oblique incidence of a light occurred at the planar interface between air and sea water. If the light originally contains both s- and p-wave components, and the incident angle is Brewster angle, then the polarization of the reflected wave from the interface is _____

- A. Perpendicular to the incident plane
- B. Parallel to the incident plane
- C. including both A and B
- D. Elliptical

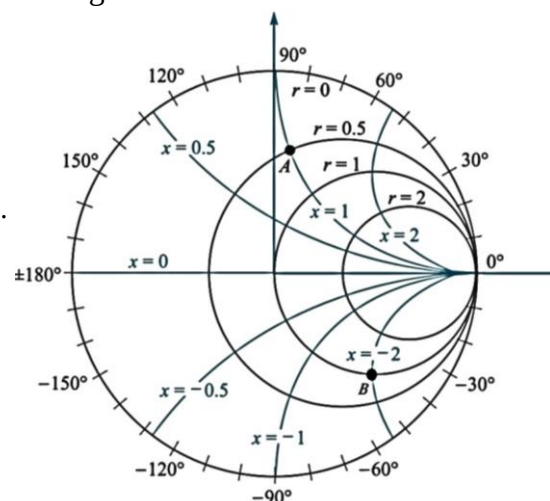
1.7 Here are some descriptions about guided waves in a hollow metal rectangular waveguide, Find out the absolutely correct statement _____

- A. The TM_{10} wave is a traveling-wave along z direction;
- B. The dominated mode of this rectangular waveguide must be TE_{10} mode;
- C. TE_{21} and TM_{21} mode can be propagated in this waveguide at the same time with the same propagation constant;
- D. A uniform plane wave can be propagated in the cavity of this waveguide.

1.8 Consider a transmission line with a characteristic impedance of 100Ω . It has a load impedance represented by point B on the following Smith Chart. Then determine the reflection coefficient at the load as _____

- A. $1-2j$
- B. $100-200j$
- C. $0.5+j$
- D. $0.5-0.5j$

Figure 2.



Part 2. Analysis and Calculation. There are 6 problems with total marks of 44.

2.1 Write the Maxwell's Equations in point form applied to time-varying electromagnetic fields. (4points)

2.2 When taking elevators inside our building, People often found that the mobile phone working at 2 GHz frequency band had very weak signal. Assume the elevator is made of stainless steel with material parameters known as $\sigma = 1.2 \times 10^6$ S/m and $\mu_r = 500$ ($\mu_0 = 4\pi \times 10^{-7}$ H/m for vacuum). Please give your explanation about the physics behind the phenomenon and calculate the related parameters. (5points)

2.3 As show in Figure 3, the location of a sliding bar is given by $x = 4t^2 + 3t$. The separation of the two rails is 80 cm. If $\mathbf{B} = 4x^3\mathbf{a}_z$ T, then find the voltmeter reading V_{ab} at $t = 0.2$ s ? (5points).

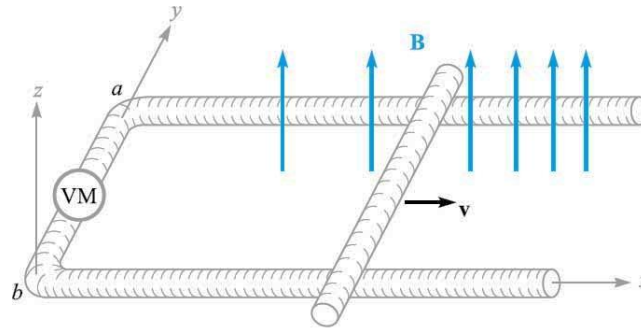


Figure 3

- 2.4 For the lossless transmission line represented in Figure 4, the length is 80m and the characteristic impedance $Z_0 = 50 \Omega$. Assume the wave velocity $v = 2c/3$, where c is the light velocity in Vacuum. find V_{in} if the working frequency f is (a) 50 Hz; (b) 500kHz; (c) and evaluate the average power delivered to the load in case (b). (10points)

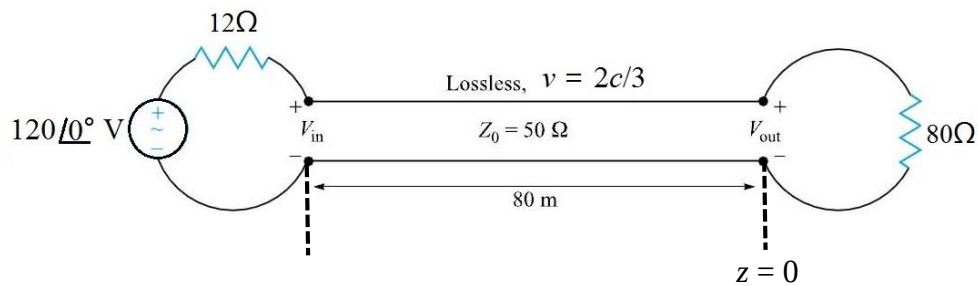


Figure 4

- 2.5 A rectangular waveguide filled with air ($n=1$) has dimensions $a = 8$ cm and $b = 5$ cm. (a) what is the dominant mode? (b) what range of frequencies can assure single-mode operation for the guide? (c) Over what frequency range will the guide support the dominant mode and next mode, but no other high-order modes? (10points).
- 2.6 If the vector of magnetic field intensity for a uniform plane wave is given by $\mathbf{H} = \cos(10^{10}t - 2\beta x)\mathbf{a}_x$ A/m, Let $\mu = 3 \times 10^{-5}$ H/m, $\epsilon = 1.2 \times 10^{-10}$ F/m, and $\sigma = 0$ everywhere. Please use Maxwell's equations to obtain expressions for $\mathbf{B}$, $\mathbf{D}$, $\mathbf{E}$, and β . (10points).

Appendix Equations for use

$$Z_{in} = Z_0 \frac{Z_L \cos \beta l + jZ_0 \sin \beta l}{Z_0 \cos \beta l + jZ_L \sin \beta l}$$

$$f_c = \frac{1}{2\pi\sqrt{\mu\epsilon}} \sqrt{\left(\frac{m\pi}{a}\right)^2 + \left(\frac{n\pi}{b}\right)^2}$$