ELEC0019 Electromagnetic Theory and Semiconductor Devices
Interference and Diffraction

Coursework Test 2023

Answer ALL questions – The test has 10 questions in two pages.

1. In relation to the setup shown in Fig. 1 of the Tutorial script,
   i) Show that with the small angle approximation (script, p.3), an approximate expression for the field intensity is given by eqn. (4). [8 marks]
   ii) If *D* = 2.55 m, *d* = 63 cm and the operating frequency is 10 GHz, what is the distance (in cm) between consecutive maxima or minima in the corresponding interference pattern? [2 marks]

2. In relation to Q2 in the script, what is the difference between the plots calculated using eqn. (1) or the approximated eqn. (4)? [10 marks]

3. For the setup shown in Fig. 2 in the script, what is the frequency of the signal in the coaxial cable that connects the detector diode to the meter? Explain. (no marks given without the explanation) [10 marks]

4. Is the current reaching the meter:
   i) proportional to $|\vec{E}|$? proportional to $|\vec{E}|^2$? neither? [2 marks]
   ii) why? [8 marks]

5. In the setups shown, in Fig. 2 in the script the polarisation of the field is along the *y*-axis. Would there be any difference if the polarisation of the sources were in the *x*-*z* plane instead?
   i) yes / no [2 marks]
   ii) explain [8 marks]

6. In relation to Fig. 3 in the script, inserting a dielectric slab ($\varepsilon_r > 1$) as shown will cause the central maximum to move:
   i) Will it move in the positive or the negative *x* direction? [2 marks]
   ii) why? [8 marks]

7. If the slab had a relative permittivity of 2.56, what would be the shift in cm observed in the interference pattern? Show your calculations. [10 marks]

8. Copy in your answer sheet your plot corresponding to the array factor for two antennas with a separation of $\lambda/2$ and phase difference of 180°. [10 marks]

9. (i) What is the difference between refraction and diffraction? (4 marks)
   (ii) Comment on the effect of diffraction in microwave communications systems. [3 marks]
   (iii) Explain the use of a grating in a device that can separate light with a narrow band of wavelengths from a white source (monochromator).? [3 marks]

10. In reference to the Experiment 2.2, do the results shown in the table in the tutorial script, indicate that the polarisation of the source is:
    i) horizontal (on the *x*-*z* plane) – or – vertical (along *y*-axis) [1 marks]
    ii) why? [6 marks]
    iii) why is there a difference between the results using a wire grid and the rhomboidal mesh? Explain. [3 marks]