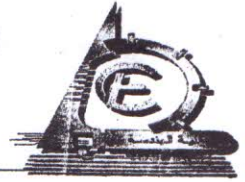




Dept. of Electrical Eng.  
Faculty of Engineering  
Assiut University  
2<sup>nd</sup> Semester - 2014/2015  
Final Exam- May, 2015

All Programs  
Course: Electromagnetic Fields (2B)  
2<sup>nd</sup> year - bylaw: 2004  
Time: 3 Hours  
Marks: 50



Important  
remarks

- This exam measures ILOs no.: a2.1 & b6.3 & c4.1 & c4.2
- No. of pages: 4, No. of questions: 4
- Solve each question in the space that is provided for it.
- Smith chart is included. It should be returned with the exam.

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$$\epsilon_c = 10^{-9} / 36\pi \text{ and } \mu_o = 4\pi \times 10^{-7}, \sigma_{\text{copper}} = 5.7 \times 10^7$$

Answer all the following questions:

Question # 1 (8 points, 3 points for (a), and 5 points for (b)):

(a) What is the frequency band, you think, that is suitable to practically use the regular waveguides? Why?

(b) Sketch the  $k-\omega$  diagrams of a parallel-plate waveguide separated by a dielectric slab of thickness  $b$  and constitutive parameters  $\mu, \epsilon$  for  $TM_1, TM_2,$  and  $TM_3$  modes. Discuss

(i) how  $b$  and constitutive parameters affect the diagrams,

(ii) whether the same curves apply to TE modes.

**Question # 2 (15 points, 5 points for (a), and 10 points for (b)):**

**(a) A standard air-filled S-band rectangular waveguide has dimensions  $a=7.21$  cm, and  $b=3.4$  cm. What mode types can be used to transmit electromagnetic waves having the following wavelengths?**

- (i)  $\lambda=10$  cm**
- (ii)  $\lambda=5$  cm.**

**(b) A  $TE_{10}$  wave at 10 GHz is the only mode propagating in a brass ( $\sigma_b=1.57 \times 10^7$  S/m) rectangular waveguide with length  $a=1.5$  cm. The guide is filled with nonmagnetic polyethylene of  $\epsilon_r=2.25$ . Determine,**

- (i) the guiding phase constant,**
- (ii) the guide wavelength,**
- (iii) the guide phase velocity,**
- (iv) the wave impedance of the guided mode,**
- (v) the group velocity of the guided mode.**

**Question # 3 (14 points, 6 points for (a), and 8 points for (b)):**

**(a) For a dielectric-filled rectangular copper cavity resonator the  $\epsilon_r=2.4$  and its dimension is  $a=b=3.6$  cm. The cavity supports only the dominant mode at frequency of 5 GHz.**

- (i) What is the length  $l$  of the cavity.**
- (ii) What is the quality factor of the cavity.**

**(b) A 6 GHz signal is to be transmitted inside a hollow circular waveguide. Determine the diameter of the waveguide such that its lowest cutoff frequency is 10% below this operating frequency. Is there any other mode can be transmitted in this waveguide?**

Note that the roots of Bessel function are:

n=0	n=1
2.405	3.832
5.52	7.016

and for the derivative Bessel function the roots are:

n=0	n=1
3.832	1.841
7.016	5.331

**Question # 4 (13 points, 3 points for (a) and 10 points for (b)):**

**(a) It is found that the attenuation on a  $150 \Omega$  distortionless two wire transmission line is  $0.01 \text{ dB/m}$ . The line has an inductance of  $0.2 \mu\text{H/m}$ .**

**(i) Find the resistance, capacitance, and conductance per meter of the line.**

**(ii) Determine the percentage to which the amplitude of a voltage travelling wave on this line decreases in 1 km distance from the transmitting end.**

**(b) A  $100 \Omega$  lossless T.L. The reflection coefficient at the load is  $0.6 \angle 60^\circ$  and the first voltage maximum is found at 4 m from the load. Calculate using smith chart:**

**(i) The load impedance.**

**(ii) The reflection coefficient at a distance 10 m from the load.**

**(iii) The voltage standing wave ratio, S, on the line.**

**(iv) The input impedance at a distance 0.5 km from the load.**

**(v) The shortest distance from the load to put a matching short circuited stub.**

**(vi) The length of the stub.**

=====**End of the questions**=====**Good Luck**=====**Prof. Elsayed Esam M. Khaled**=====