NATIONAL EXAMS, MAY 2017

16-ELEC-A7, ELECTROMAGNETICS

3 HOURS DURATION

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.

2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a closed book exam.

3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.

4. All questions are of equal value.

5. Aids: $\varepsilon_0 = 8.85 \times 10^{-12}\ F/m,$ $\mu_0 = 4\pi \times 10^{-7}\ H/m$

1. A pulse generator of 377 ohm internal impedance drives an infinite transmission line of 377 ohm characteristic impedance and 3×10^8 m/s propagation velocity. At about 10 km distance from the generator two 377 ohm resistances are connected across the line at a spacing of 500 m apart. The generator launches a single pulse containing 1 joule of energy.

   (I) What is the longest length of pulse width that will produce non overlapping reflections of pulses reflected from two 377 ohm resistances?

   (II) Plot as a function of time powers of the first two reflected pulses arriving at the generator terminals

2. A section of transmission line of 50 ohm characteristic impedance and 3×10^8 m/s propagation velocity carries simultaneously 300 MHz and 150 MHz signals. The line is terminated in a parallel connection of two sections of the same line, both sections terminated in 50 ohm resistance designated A and B. A 50 cm long open-circuited section is connected 50 cm from the connection to the driving line across the line terminated in resistance A. A 50 cm long short-circuited section (of the same line) is connected 25 cm from the junction with the driving line across line terminated in resistance B.

   Which of the A and B resistances will receive the 300 MHz and 150 MHz signals?

   Note: All lines and line sections in this problem are 50 ohm, 3×10^8 m/s lines.

3. A strip line consists of two parallel straight metallic ribbons 2 cm wide separated by 0.5 mm thick layer of dielectric of relative permittivity 2.25.

   Calculate, disregarding fringe fields distributed capacitance and inductance of the line and its characteristic impedance and propagation velocity.

4. Inside dimensions of a rectangular waveguide are 2.4 cm x 1 cm.

   For what value of relative permittivity of dielectric completely filling the waveguide will the cut-off frequency of the lowest propagating mode be 4.2×10^9 Hz?

5. Direction of propagation of a linearly polarized 10 GHz plane wave is 45 ° up from horizontal. Power density of the wave is $0.1 W/m^2$ and its magnetic field is polarized in the horizontal direction.

   What is the RMS value of the vertical component of the electric field of the wave?

6. A 2A current loop consists of two 5 cm diameter semicircles with common diameter. One of the semicircles lies in the horizontal plane, the other in vertical one. The common diameter points in the north-south direction. Viewed from above the current circulates clockwise.

   What is the magnitude and direction of magnetic field produced by the loop at midpoint of the common diameter?

7. A horizontal square loop of 1 m^2 area with sides aligned in north-south and east-west directions moves horizontally north at 30 m/s velocity. It encounters a vertical, east-west wall of uniform magnetic field 100 m wide. Magnetic field in the wall is 10^{-4} teslas strong and points east and 45° up.

   Plot EMF induced in the loop.

8. A 1 m long vertical circuit element radiates 10 MHz and 5 MHz signals into empty space. Current amplitudes at both frequencies are the same. At a point 10 km away horizontally, the RMS value of the 10 MHz electric field is 100 μ V/m.

   Calculate the RMS value of the vertical component of the 5 MHz field at a point 2.0 km above the point specified for the 10MHz signal.