UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE
Department of Electrical and Electronic engineering

MAIN EXAMINATION 2016

Title of the paper:
Electromagnetic Fields II

Course Code: **EE441**
Time allowed: **Three Hours**

Instructions:
1. To answer, pick any 5 of the 7 questions in the following pages.
2. The answer must be written in the space provided in the question book; those in elsewhere considered invalid. Use the answer book as a scratch pad. Both question and answer book must be handed-in and marked with name and ID.
3. This paper has 9 pages, including this page and a Smith Chart.

DO NOT OPEN THIS PAPER UNTIL
PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

Q1: (20 pts) Given a rectangular loop, 0.4x0.6 Mtr, shown in Fig. Q1-1, with a resistance of 0.5 Ω, which rotates 6000 rpm in a uniform magnetic flux density, $\vec{B} = 50\vec{u}_y$ mT. (i)(5 pts). Find the emf induced in the loop as a function of time. The loop has 4 sides; which side is effectively induced this emf if any? (ii) (5 pts). Find the direction of the current with respect to the coil position. (iii)(10 pts). Which sides are induced no emf if any? Give the reason behind in a vector equation (hint: 1. top and bottom sides have different reason from the $\vec{u}_z$ side. 2. $v_{12} = -\int_{p1}^{p2} \vec{V} \times \vec{B} \circ d\vec{l}$).

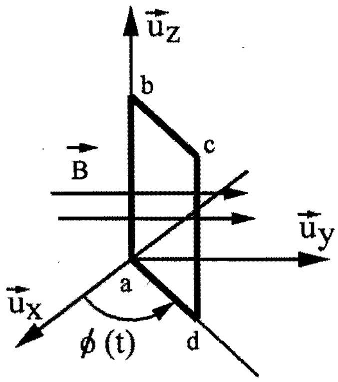


Fig. Q1-1

Q2: (20 pts) An EM wave of 20 MHz in a medium of $\mu_0/\varepsilon_r=4$ has the **H** field:

$$\vec{H} = \vec{u}_y \cos 2z \cdot \cos(\omega t - \beta x)$$

Determine (i). **E**-field, (ii). propagation direction and constant β, (iii). the charge density ρ_v, and (iv). The displacement current density $\mathbf{J_d}$. (5 pts each)

Q3: (20 pts) Explain in detail but concise the key wave specifications, which characterize the wave behaviors in a medium. (hint: minimum 4 items) (5 pts for each item)

Q4: (20 pts) A plane wave in air with,

$$\overline{E}^{i} = \vec{u}_y \cdot 20e^{-j(3x+4z)}$$

Is incident upon the planar surface of a dielectric material, with ε_r=4, occupying the half-space z ≥ 0. Determine: (i). the polarization of the incident wave, (ii). the angle of incidence, (iii). the angle of the refraction, and (iv). the power carried in the incident wave. (5 pts each)

Q5: (20 pts) In response to a step voltage 8V, the voltage waveform shown in Fig. Q5-1 was observed at the load side of a lossless transmission line with Z_o= 50 Ω and u_p=0.8 C. Determine: (i). the length of the line, (ii). Γ_L and Γ_S, (iii). R_S, and (iv). R_L (5 pts each)

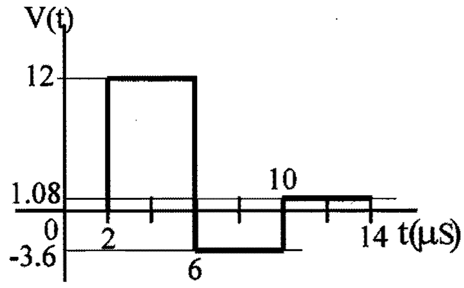
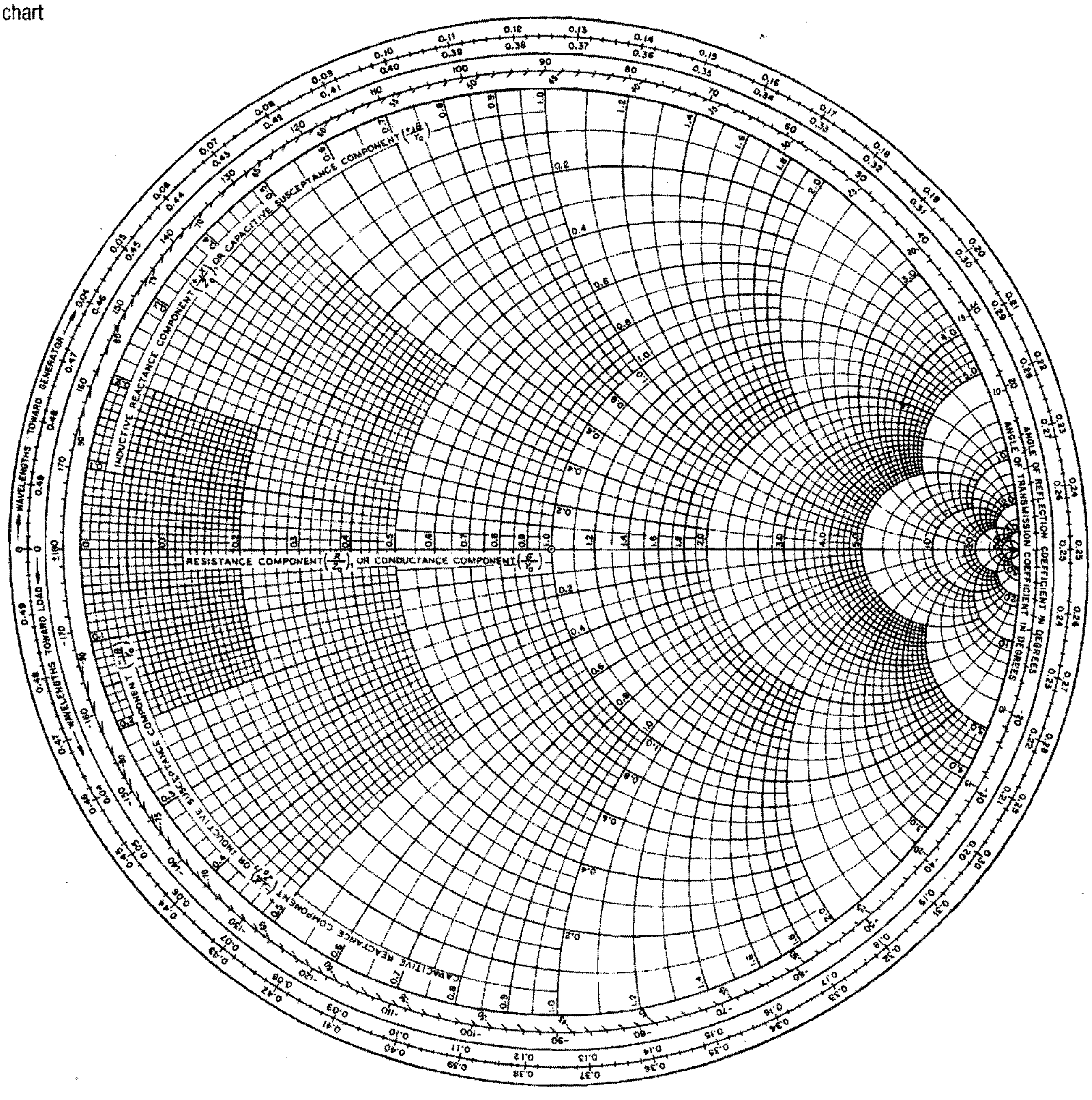


Fig. Q5-1

Figure A.6 A standard Smith chart



Q6: (20 pts) A lossless TV transmission line of 75 Ω feeds a dipole antenna of impedance 70+j40 Ω. (i). Find VSWR. To improve the VSWR design a shorted matching stub of the same R_o=75 Ω, (ii). Calculate the location from the load to put the stub, (iii). The stub length, and (iv). By insert a $\lambda/4$ transformer between the load and transmission line, find the location and the Z_o of the transformer. (5 pts each)

Q7: (20 pts) For an antenna whose normalized radiation intensity is given by

$F(\theta,\varphi) = 1, \ldots\ldots for. 60 \leq \theta \leq 120, \ldots\ldots -30 \leq \varphi \leq +30$

$F(\theta,\varphi) = 0, \ldots\ldots elsewhere$

Determine: (i). The direction of maximum radiation, (ii). Directivity, (iii). Beam solid angle, and (iv). Half-power beamwidth in x-z plane. (5 pts each)