JUAS 2003 RF-Technology – EXAMINATION Name:

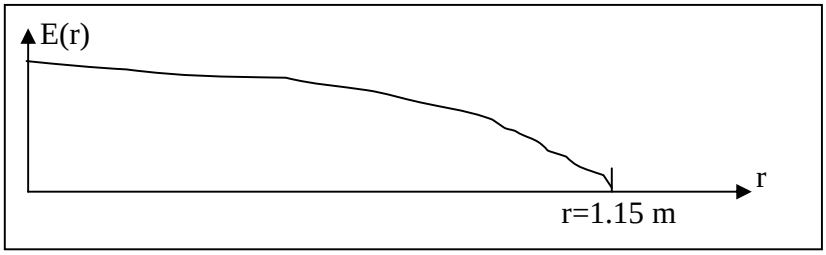
1 For a given pillbox cavity with a radius R = 1.15 meter and a height H=0.5 meter determine **(7P)**

1.1 the resonance frequency for the fundamental mode (TM_{010} type) (1P)

$f = c_0/(2.61a) = 100$ MHz

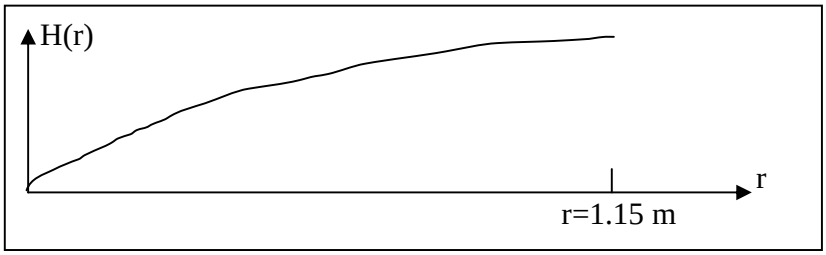
1.2 Indicate qualitatively below the electric field strength E(r) as a function of radius. It is proportional to which function? (1P)

To I_0 (Bessel function of 0^{th} order).



1.3 Indicate qualitatively below the magnetic field strength H(r) as a function of radius. It is proportional to which function? (1P)

To I_1 (Bessel function of first order).



1.4 Which are the ONLY present E- and H- field components in the cavity for the mode mentioned above? (r,φ and z coordinates) (1P)

$H_r, H_f, E_r, E_\phi, E_z$

1.5 Calculate (general expression and numerical solution) the R/Q and the Q value assuming that the cavity is made from normal copper at room temperature. Neglect the transit time factor! (2P)

$R/Q = 370*(H/2)/R = 80.4$, $Q = 0.383/\sigma*(1+0.192\lambda/(H/2))^{-1} = 52700$

1.6 What is the decay time τ of cavity version 1. (1P)
(general expression using the Q value and numerical result)

$t = Q/(\pi*f) = 168\ \mu s$

JUAS 2003 RF-Technology – EXAMINATION Name:

2 Fill in all the missing fields in the tables below **(7P)**

2.1 (2P)

Voltage ratio	Power ratio	dB
3.1623	*10*	*10*
10	100	*20*
100	*10000*	40

2.2 (2P)

dBm (50 Ohm)	RMS Voltage	milli Watt
0	*0.224 V*	*1*
+30	*7.1 V*	*1000*
-60	*0.224 mV*	*1e-6*
20	*2.4 V*	100

2.3 (1P)

We have got part of the S-matrix of an ideal attenuator. Fill in the missing elements.
How many dB are written on this attenuator for its nominal attenuation?

$$[S] = \begin{bmatrix} 0 & 0.1 \\ 0.1 & 0 \end{bmatrix}$$

2.4 (2P)

Now we have an ideal amplifier with perfect input and output match (i.e. input and output impedance are both 50 Ohm) a gain of 40 dB and no reverse transmission.
(import: port 1, output: port 2)

$$[S] = \begin{bmatrix} 0 & 0 \\ 100 & 0 \end{bmatrix}$$

JUAS 2003 RF-Technology - EXAMINATION Name:

3. The locus of inpedance of a parallel RLC resonant circuit (without additional transformers) **(6P)** is given in the complex w-plane (left) [w-plane = normalized z-plane, normalization to 50 Ohm].

3.1 Tranform this locus of impedance into the Smith Chart. *See Smith Chart* (1P)

3.2 Mark the resonance frequency both in the w-plane and in the Smith Chart (select between f1, f2, f3). *Point C (f2)* (1P)

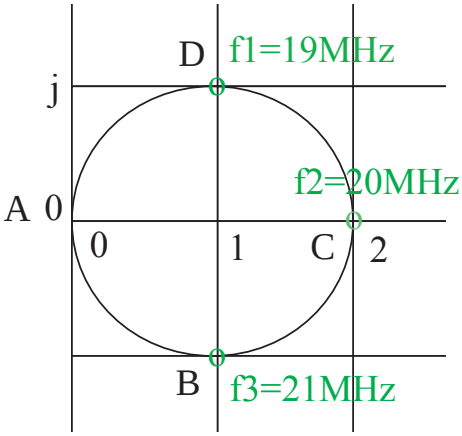
3.3 Show (with a mark) the -3dB points (for unloaded Q) both in the w-plane and in the Smith Chart (select between f1, f2, f3). *Points B and C (f1 and f3)* (1P)

3.4 Determine R and Q and subsequently L and C for this resonator. (2P)

3.5 What is R/Q for this resonator? (1P)

Q = 10, R = 100 Ohms, R/Q = 10, L = 79.6 microH, C = 796 pF

w-plane



Smith Chart