Measurement & Instrumentation

Midterm Exam

$$U = \sqrt{\left(\frac{a}{\sqrt{2}}\right)^2 + \left(\frac{5}{\sqrt{2}}\right)^2} = 7,9\,V$$

$$I^2 = \left(\frac{1}{\sqrt{2}}\right)^2 + \left(\frac{2}{\sqrt{2}}\right)^2 \rightarrow I = 1,58\,A$$

1) The voltage across a load Z and the current through it are given as

u(t)= a·cos (ωt) + 5·cos (7ωt-π/6) [V] $P = \frac{a}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{2} + \frac{5}{\sqrt{2}} \cdot \frac{2}{\sqrt{2}} \cdot \frac{1}{2} = 5 \rightarrow \boxed{a = 10}$

i(t) = cos (ωt+ π/3) + 2·$\underbrace{\sin (7\omega t)}_{\cos(7\omega t - \pi/2)}$ [A]

which cause a power dissipation of 5W in the load. $\boxed{p.f. = \frac{P}{U \cdot I} = \frac{5}{7,9 \cdot 1,58} \simeq 0,4}$

15 p a) Calculate 'a'.

15 p b) Calculate the power factor of Z.

$$\left(U \cdot \sqrt{\frac{2}{5}}\right)^2 + \left(U \frac{1}{\sqrt{5}}\right)^2 = 3^2 \rightarrow \boxed{U = \sqrt{15}}$$

2) A moving-*iron* V-meter reads the voltage in Fig.2 as 3V.

$1,11 \cdot U_{m\,abs} = \frac{3U}{5} \cdot 1,11 \cong \boxed{2,58V}$

15 p a) Calculate U.

20 p (10 +10) b) Which values do a *full*-wave rectifier instrument and a moving-*coil* V-meter read for this voltage? $\frac{U}{5} \cong \boxed{0,77\,V}$

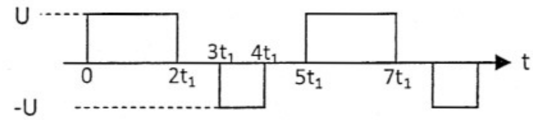

Figure 2

3) In the circuits given below, the characteristics of the instruments are as follows:

15 +15 p. **V-m**: 30V, cl_V=0.5 ; **A-m**: 6A, cl_A= 1 .

The constructional errors for the resistor and the inductor are 1% and 0.5% respectively.

Calculate the power drawn by the load (R-L) and the maximum possible *instrumental* error in computing power.

V1 = 20 V
A1 = 0,5 A

$P = \frac{U^2}{R} = \boxed{40W}$

$\frac{\Delta P}{P} = 2\frac{\Delta U}{U} + \frac{\Delta R}{R} = \%1,5 + \%1 = \boxed{\%2,5}$

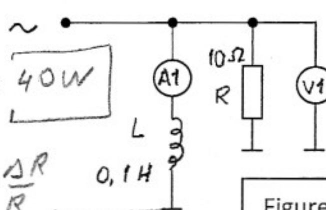

Figure 3a

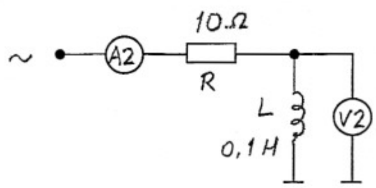

Figure 3b

V2 = 20 V
A2 = 1 A

$P = I^2 R = \boxed{10W}$

$\frac{\Delta P}{P} = 2\frac{\Delta I}{I} + \frac{\Delta R}{R} = \boxed{\%13}$

4) A magnitude 'x' is calculated as x=(2a+b)/c. All the parameters (a,b,c) are assumed to show

25 p- *Gaussian* distribution and the absolute uncertainties of the parameters are given as:

u_a= 0.1 [u] at **95**% confidence level

u_b= 0.06 [u] at **95**% confidence level

120 p- u_c= 0.1 [u] at **68**% confidence level $\rightarrow$ 0,2 at 95%

For a=2, b=1 and c=4 , calculate the uncertainty in evaluating 'x' at **95**% confidence level if the uncertainties of the parameters (a,b,c) are *uncorrelated*.

$$u_x = \sqrt{\left(\frac{\partial x}{\partial a} \cdot u_a\right)^2 + \left(\frac{\partial x}{\partial b} \cdot u_b\right)^2 + \left(\frac{\partial x}{\partial c} \cdot u_c\right)^2} = \sqrt{\left(\frac{2}{c} \cdot 0,1\right)^2 + \left(\frac{1}{c} \cdot 0,06\right)^2 + \left(\frac{-(2a+b)}{c^2} \cdot 0,2\right)^2}$$

$\cong \boxed{\pm 0,08\ [u]}$ $\boxed{x = 1,25 \pm 0,08\ [u]}$