1) a) $ff = \frac{X_{ef}}{X_{m\,abs}} \rightarrow ff^* = \frac{X_{ef}/\sqrt{2}}{X_{m\,abs}/2} = \sqrt{2}\cdot ff = \sqrt{2}\cdot 1{,}15$

b) $U_{m\,abs} = \frac{U_m \cdot t_1/2}{2t_1} = \frac{U_m}{4} \rightarrow U = \frac{U_m}{4}\cdot 1{,}11$

16.04.2013

Measurement & Instrumentation

Midterm Exam

1) The form factor of a *triangle* wave is 1,15. According to this information,

20 a) Calculate the form factor of the signal in Fig.1

20 b) Which value does a full-wave rectifier instrument read for this signal? (Calculate the reading in terms of U_m).

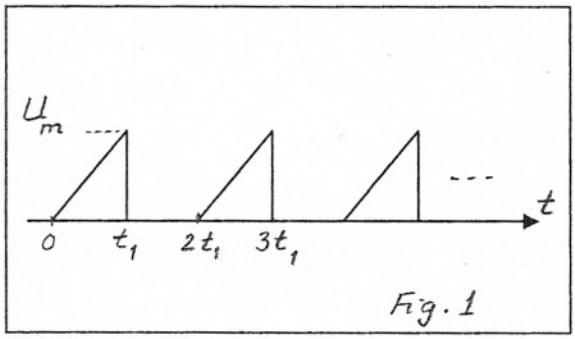

Fig. 1

25 2) A magnitude 'x' is calculated as $x = a + b/c^2$, where

'a' is given as a = 10.0 [u] with its *significant* numbers,

'b' is given as b = 5 ± 0.03 [u]

'c' is given as c = 5 [u] , 1%

Calculate the relative error in evaluating 'x' .

$\Delta x = \Delta a + \frac{1}{c^2}\cdot\Delta b + \frac{2b}{c^3}\cdot\Delta c$

$= 0{,}05 + \frac{1}{25}\cdot 0{,}03 + \frac{10}{125}\cdot 0{,}05$

$= 0{,}0552$

$\frac{\Delta x}{x} = \frac{0{,}0552}{10{,}2} = \%\,0{,}54$

3) In Fig.2

Z_1 is an *inductive* load of 100 Ω, $\cos\varphi_1 = 0.8$.

Z_2 is an *inductive* load of 100 Ω.

W-m : 300V, 5A, 60 div. , R_{aw}= 10 mΩ, R_{vw}= 100kΩ

30 a) Calculate the power factor of Z_2 , if the wattmeter deflects by 30 divisions.

15 b) Calculate the *relative* method error in power measurement.

110 p.

a) $P_{tot} = P_{Z_1} + P_{Z_2} = \frac{300\cdot 5}{60}\cdot 30 = 750\,W$

$P_{Z_1} = \frac{220^2}{100}\cdot 0{,}8 = 387{,}2\,W$

$P_{Z_2} = 362{,}8\,W$

$= \frac{220^2}{100}\cdot\cos\varphi_2$

$\cos\varphi_2 \cong 0{,}75$

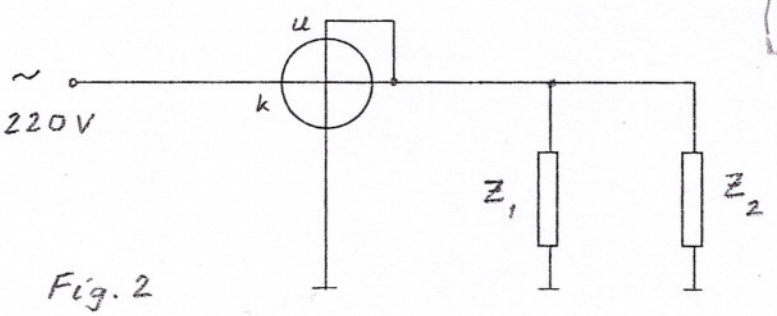

Fig. 2

b) $\Delta P|_{met.} = \frac{220^2}{R_{V_W}} \cong 0{,}5\,W$

$\left.\frac{\Delta P}{P}\right|_{met} \cong 0{,}06\,\%$

750 W

15.04.2014

Measurement & Instrumentation

Midterm Exam

1) Given the voltage $u(t)= 1 - a\cdot\cos(\omega t-\pi/6)$ [V] with a<1.

$U_{m_{abs}} = 1$, $U_{ef} = \sqrt{1^2 + \left(\frac{a}{\sqrt{2}}\right)^2} \rightarrow ff = \frac{U_{ef}}{U_{m_{abs}}} = 1,2 \rightarrow a \cong 0,94$

20 a) Calculate 'a' if the form factor of u(t) is ff=1,2.

15 b) Which value does a full-wave rectifier instrument (V-m) read for this input voltage?

$U_{fwr} = U_{m_{abs}} \cdot 1,11 = 1,11\ V$

2) In Fig. 2:
u(t) = 10·cos(ωt) [V], R=10Ω. The measuring instruments and the diodes are considered to be ideal. Which value does

15 a) the moving-coil Ammeter $I_m = \frac{0,5}{\pi} = 0,16A$

15 b) the moving-iron V-meter read?

$U_{ef} = \frac{5}{2} = 2,5\ V$

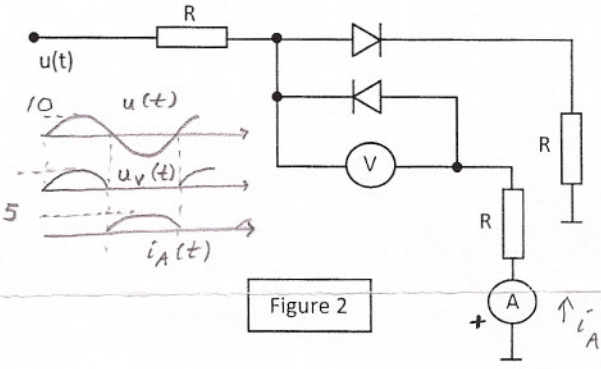

Figure 2

3) In Fig.3 the instruments have the following characteristics:
Wh-m: 220V, 10A, 750rev/kWh
W-m: 250V, 10A, 50div., cl_w=0.5
A-m: 3A, 30div., cl_A=1
Current transformer CT1: 25A/5A, cl_{ct1}=0.2
Current transformer CT2: 10A/5A, cl_{ct1}=0.2

The W-m deflects by 30 divisions and the Ammeter reads 2A.

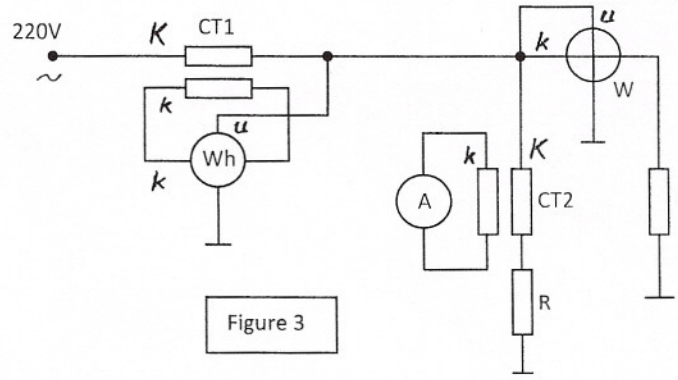

Figure 3

20 a) Calculate the total power (P_{tot}) drawn by the loads.

20 b) Evaluate the instrumental error in calculating P_{tot}.

15 c) How long does it take for the electromechanical Wh-meter to complete 20 revolutions?

120 p.

a) $P_z = P_w = \frac{250 \cdot 10}{50} \cdot 30 = 1500\ W$, $P_R = \left(k_{I_z} \cdot I_A\right)^2 \cdot R = U \cdot I_R = 220 \cdot 4 = 880\ W$

$P_{tot} = 2380\ W$

b) $\Delta P_{tot} = \Delta P_z + \Delta P_R = \%0,5 \cdot 2500 + \underbrace{\left(\%1 \cdot \frac{3}{2} + \%0,2\right)}_{\Delta I_R / I_R} \cdot 880 = 27,46\ W \rightarrow \frac{\Delta P_{tot}}{P_{tot}} = \%1,15$

c) $t = \frac{3600\,000}{750 \cdot \frac{2380}{5}} \cdot 20 \cong 201,7\ sec.$