LABORATORIO DI FISICA SPERIMENTALE

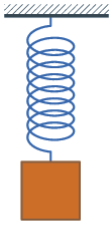
Ingegneria meccanica

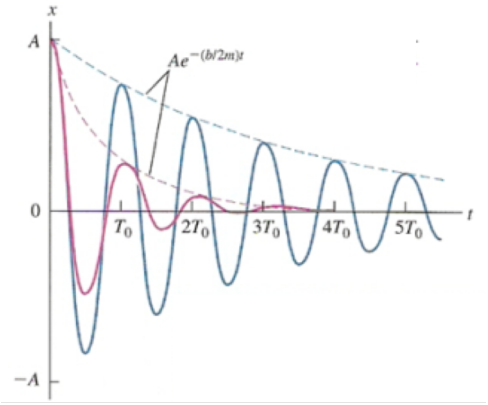
A.A. 2016-2017

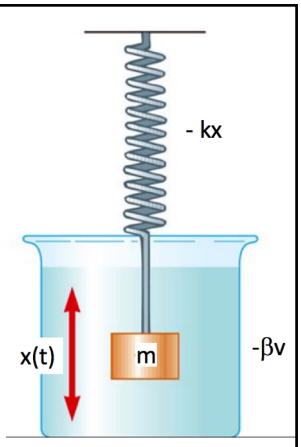
Settima esperienza:
oscillazioni smorzate e forzate

lasciate il tavolo di laboratorio in ordine e pulito;
ne siete responsabili (anche della strumentazione)

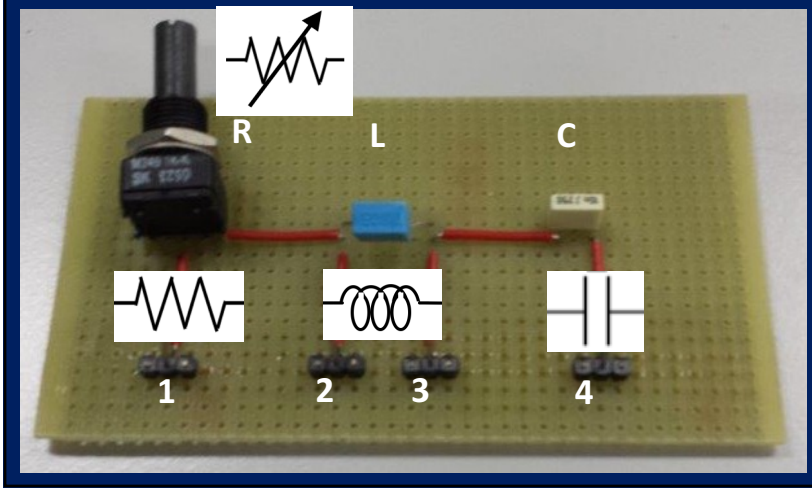
$$m\,d^2x/dt^2 + \beta\,dx/dt + k\,x = F_0$$







IL SISTEMA DA STUDIARE: circuito elettrico costituito da
1-2 resistenza R (variabile: potenziometro)
2-3 induttanza L (celeste)
3-4 capacità C (gialla)
connessi tramite conduttori



OSCILLAZIONI SMORZATE

1-2 resistenza	R	$V_R = R\,I$ (legge di Ohm)
2-3 induttanza	L	$V_L = L\,dI/dt$
3-4 capacità	C	$V_C = 1/C \int I\,dt$

In questa disposizione (serie) gli elementi sono attraversati dalla stessa corrente $I(t) = dQ/dt$ (Q è la carica elettrica) mentre le differenze di potenziale presenti i capi dei componenti si sommano:

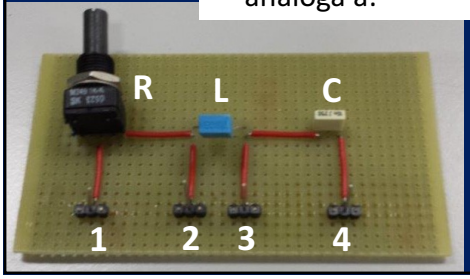
$V_{1\text{-}4} = V_{TOT} = V_R + V_L + V_C = R\,I + L\,dI/dt + 1/C \int I\,dt$

Sostituendo $I = dQ/dt$ si ha $V_{TOT} = R\,dQ/dt + L\,d^2Q/dt^2 + 1/C\,Q$

Essendo → $Q = C\,V_C$ → $\mathbf{V_{TOT} = RC\,dV_C/dt + LC\,d^2V_C/dt^2 + V_C}$

riordinando... $LC\,d^2V_C/dt^2 + RC\,dV_C/dt + V_C = V_{TOT}$

analoga a: $m\,d^2x/dt^2 + \beta\,dx/dt + k\,x = mg$



$LC\ d^2V_C/dt^2 + RC\ dV_C/dt + V_C = V_{TOT}$

$m\ d^2x/dt^2 + \beta\ dx/dt + k\ x = F_0$

$d^2x/dt^2 + \beta/m\ dx/dt + k/m\ x = F_0/m$

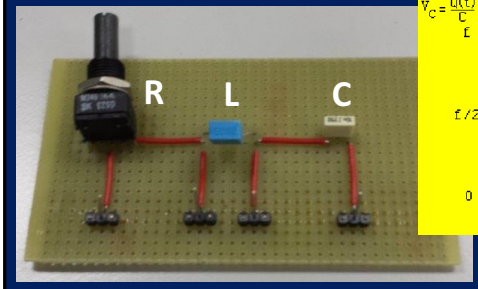
$d^2x/dt^2 + 2\gamma\ dx/dt + \Omega^2\ x = F_0/m$

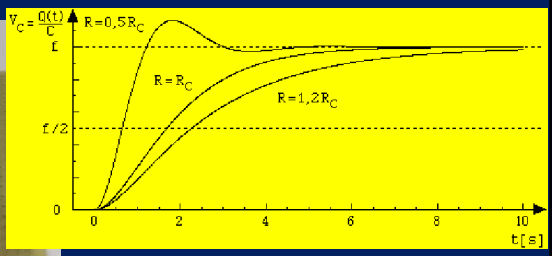
$d^2V_C/dt^2 + R/L\ dV_C/dt + 1/LC\ V_C = 1/LC\ V_{TOT}$

$\gamma = 2R/L \qquad \Omega^2 = 1/LC$

Smorzamento critico se $R = R_c = 2\sqrt{\frac{L}{C}}$

Sottosmorzamento: $V(t) = V_0 e^{-\gamma t}\cos(\omega t + \varphi)$





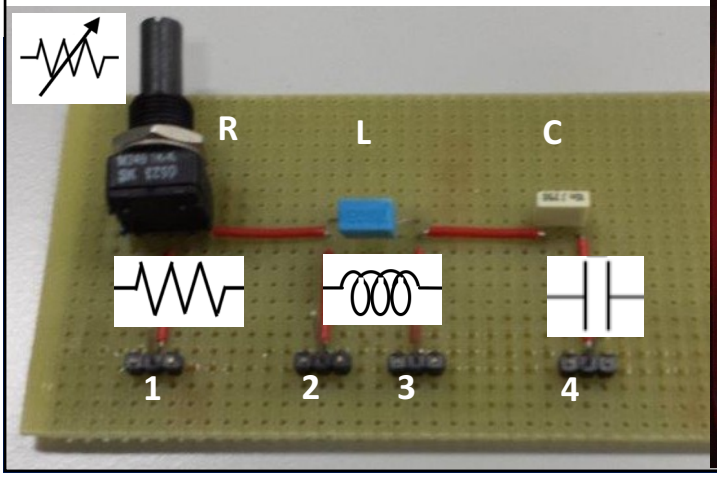
1) MISURA COMPONENTI

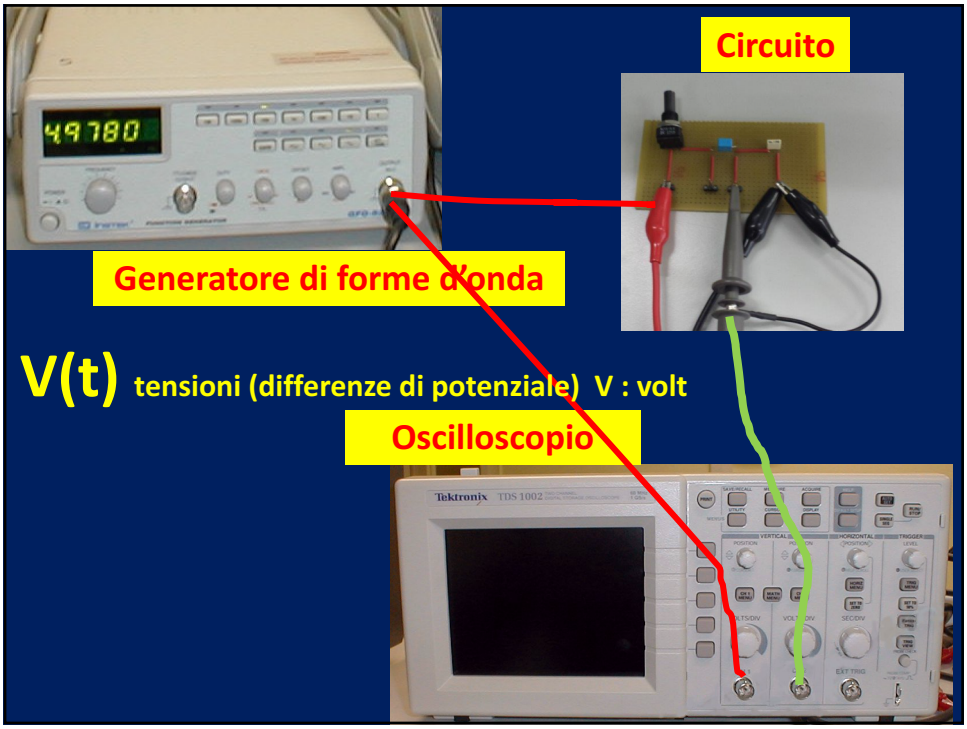
Misurare il valore massimo e minimo di R e i valori di L e C:

1-2 resistenza R (Ω ohm) → R_{min} = xxx Ω R_{MAX} = xxx kΩ

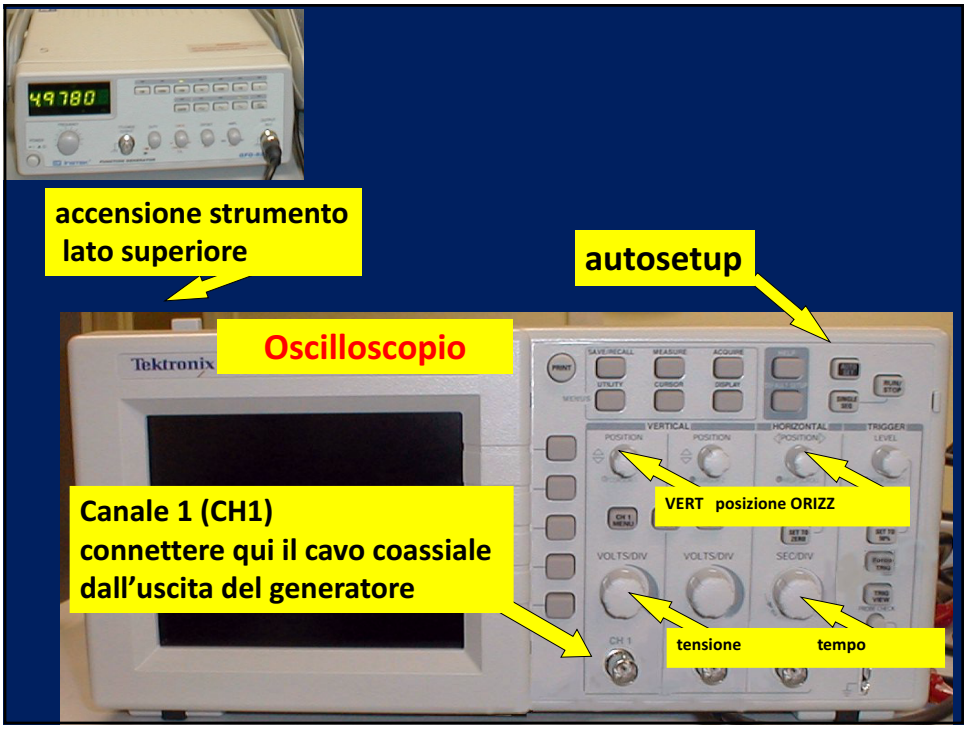
2-3 induttanza L (H henry) → L = xxx mH

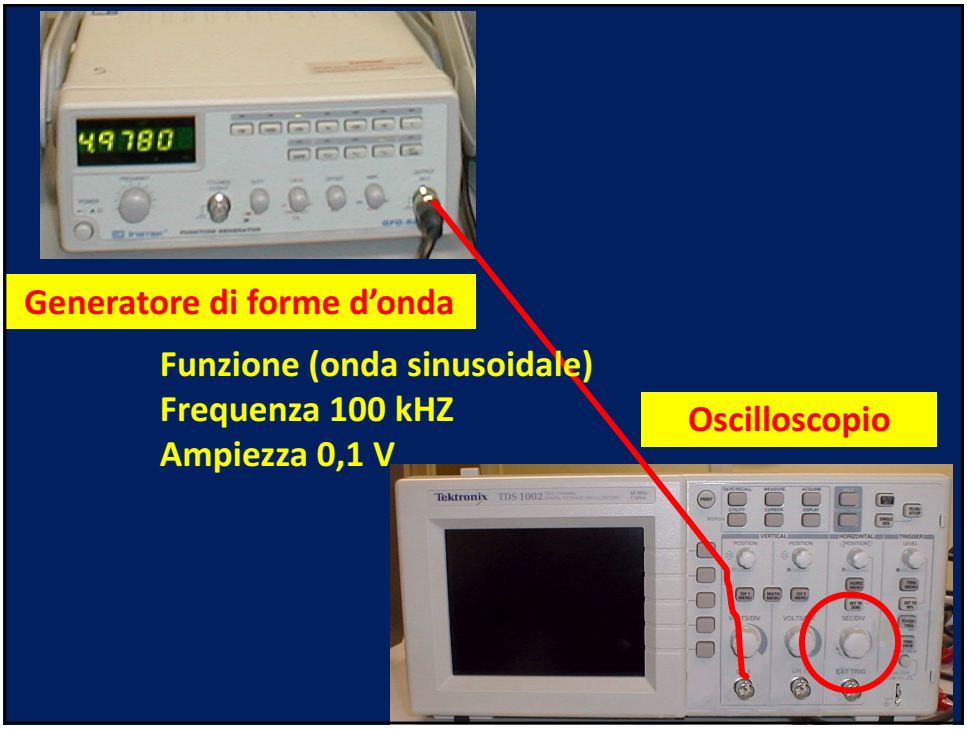
3-4 capacità C (F farad) → C = xxx nF

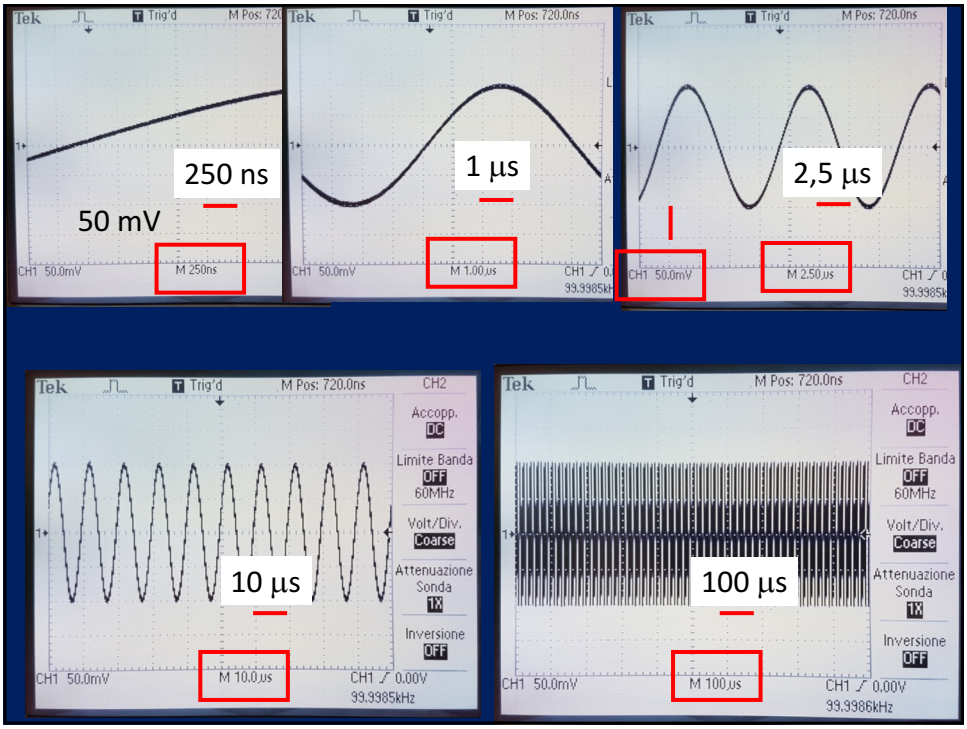



Circuito
Generatore di forme d'onda
V(t) tensioni (differenze di potenziale) V : volt
Oscilloscopio

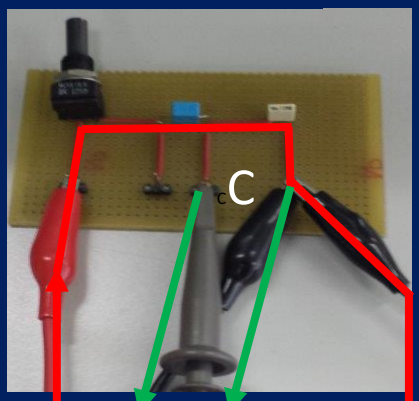

frequenza (grosso)
forma d'onda
frequenza (fine)
ampiezza (V_{pp})
1M
100k
10k
1k
100
10
1
NON VANNO EFFETTUATE MOLTIPLICAZIONI

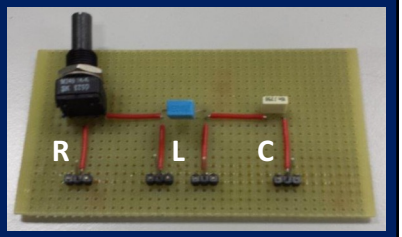

accensione strumento
lato superiore
autosetup
Oscilloscopio
Canale 1 (CH1)
connettere qui il cavo coassiale
dall'uscita del generatore
VERT posizione ORIZZ
tensione
tempo


Generatore di forme d'onda
Funzione (onda sinusoidale)
Frequenza 100 kHZ
Ampiezza 0,1 V
Oscilloscopio



2) OSCILLAZIONI SMORZATE



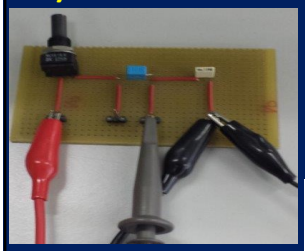


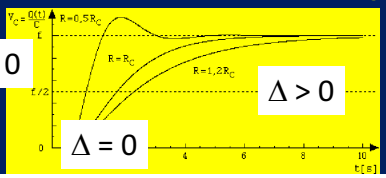
IMPOSTARE FORMA D'ONDA QUADRA

OSCILLOSCOPIO

CORRENTE DAL/AL GENERATORE DI FORME D'ONDA

2A) OSCILLAZIONI SMORZATE → DETERMINAZIONE R_C



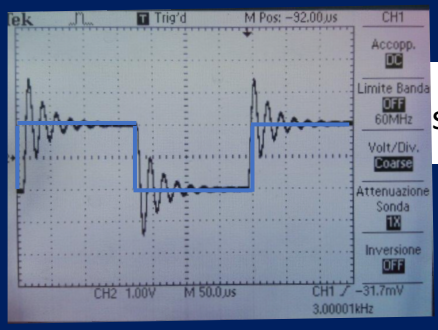


$\Delta < 0$

$\Delta > 0$

$\Delta = 0$

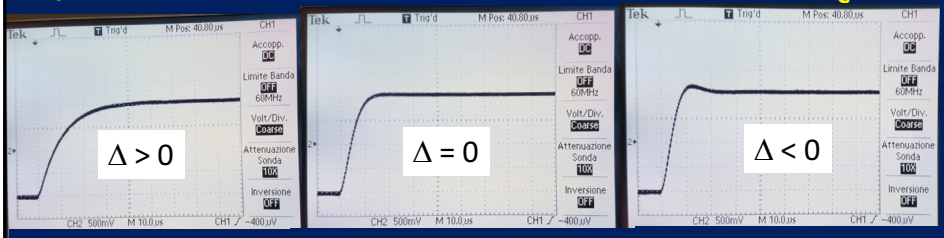
ruotare R per determinarne il valore più piccolo per il quale non si osservano oscillazioni



smorzamento critico: $R_c = 2\sqrt{\frac{L}{C}}$

Funzione (onda quadra)
Frequenza 3 kHZ
Ampiezza 2 V

2A) OSCILLAZIONI SMORZATE → DETERMINAZIONE R_C



$\Delta > 0$ $\Delta = 0$ $\Delta < 0$

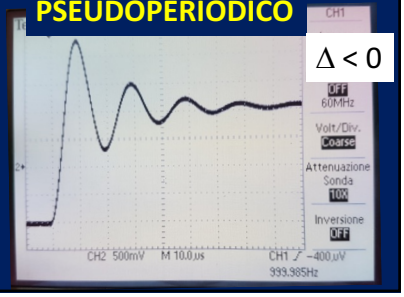
SOVRASMORZATO **SMORZAMENTO CRITICO** **SOTTOSMORZATO**

smorzamento critico: $R_c = 2\sqrt{\frac{L}{C}}$

DAL GENERATORE

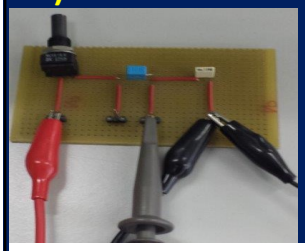
$\gamma \rightarrow 0$

PSEUDOPERIODICO



$\Delta < 0$

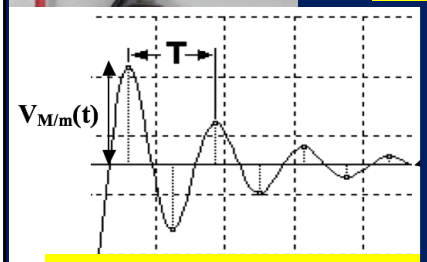
2B) OSCILLAZIONI SMORZATE → DETERMINAZIONE T e γ



ruotare R per ottenerne il valore più piccolo --> si osserva il massimo numero di oscillazioni

$$V(t) = V_0\, e^{-\gamma t} \cos(\omega t + \varphi) + f$$

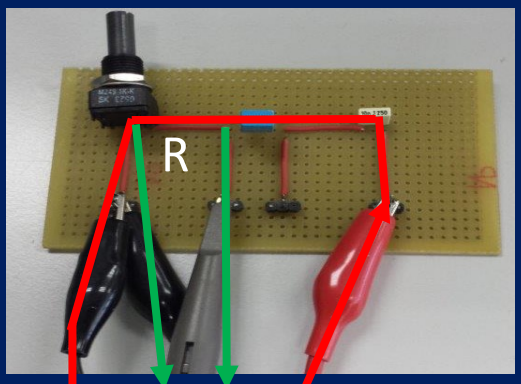
$$V_{M/m}(t) = V_0\, e^{-\gamma t}$$

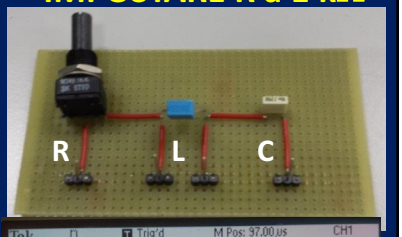


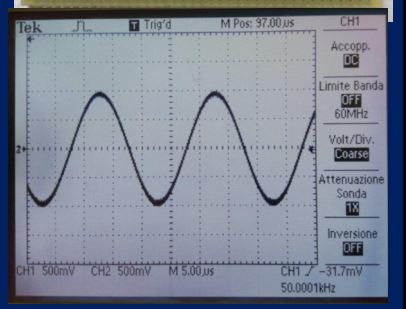
- Tabulare le misure di $V_{M/m}$
- Graficare ln $[V_{M/m}(t)]$ *vs* t
- Ricavare $\gamma = 2R/L$ dalla pendenza della retta
- $T = \frac{2\pi}{\omega} = 2\pi\sqrt{LC}$

3) OSCILLAZIONI FORZATE → RISONANZA

IMPOSTARE R a 1 kΩ



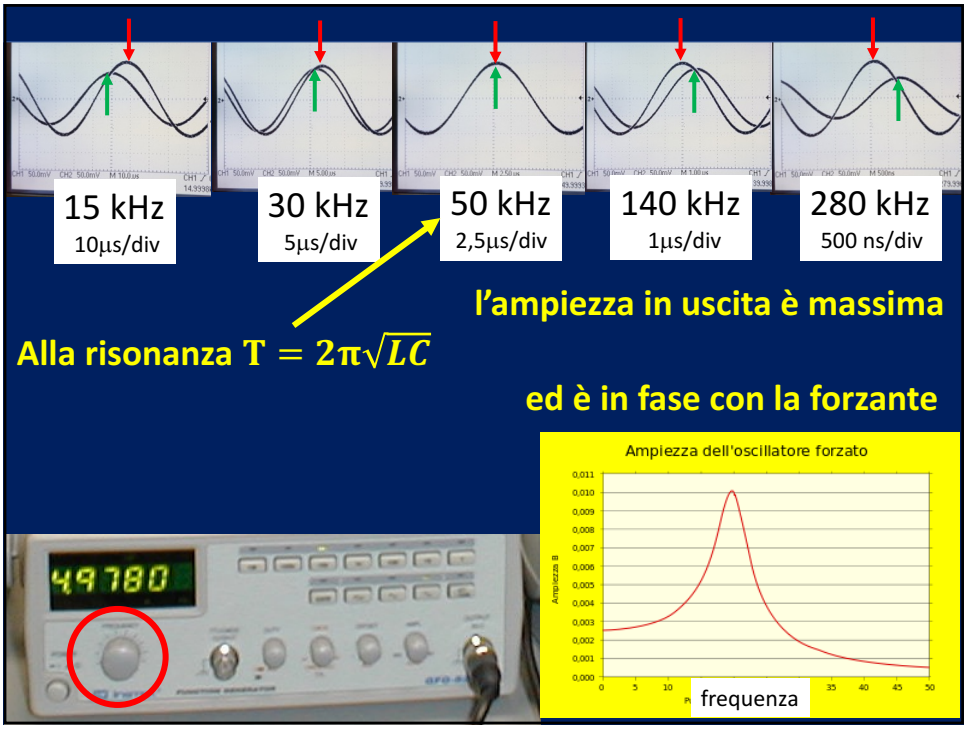




OSCILLOSCOPIO

CORRENTE DAL/AL GENERATORE DI FORME D'ONDA

IMPOSTARE FORMA D'ONDA SINUSOIDALE



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A.A. 2016-2017

a venerdì 5 maggio