# Final Exam, Circuit Theory
# 50 Marks

## 1 Instructions

1. Please use the last two digits of your roll number as KEY. If the last two digits is 00, then please use KEY as 100.
2. No type of discussion is permitted during the exam through any means. Any type of discussion will be construed as academic dishonesty and accordingly penalized.
3. If any question is incomplete or unclear, please raise the comment privately. No public discussion is permitted. If the instructor is unable to clarify the question, then please make assumptions, write it down in the solution and proceed.
4. Please turn in the solution through Google classroom. Any solution that is turned in over email will not be counted.
5. No late submission is allowed. An extra 30 minutes has been given for uploading the solutions. So no additional time will be provided.
6. The exam consists of 4 short questions of 5 marks each and 3 long questions of 10 marks each.
7. Any MATLAB or Python based script that is used for the solutions must be included as part of the solution during submission.

## 2 Question Paper

### 2.1 Short questions (5 marks each)

1. Consider the time-domain fully rectified signal $f(t) = |A\cos(\frac{2\pi}{KEY}t)|$. Plot the time-domain function. What is the time period? What is the fundamental harmonic frequency? Find its Fourier series expansion.
2. For the circuit shown in Fig.1, at what frequency of the input excitation, will the voltage across the input be in phase with the input current?

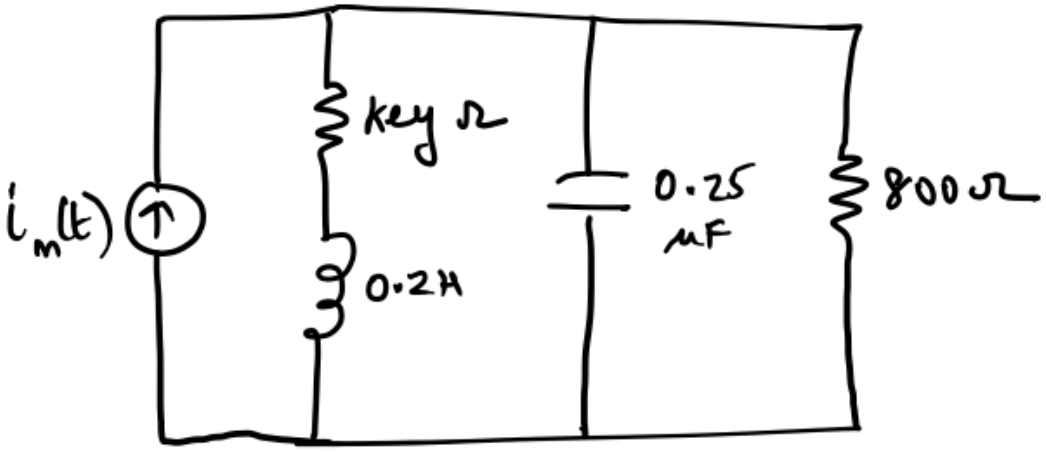


Figure 1:

3. The input function to a linear time invariant system is $v_{in}(t) = 2te^{-2t}u(t)$ and the impulse response of the system is given by $h(t) = 3u(t-1)$. Find the time-domain output of the LTI system.

4. A system $\frac{V_{out}}{V_{in}}$ has a transfer function with poles at $s = \pm jKEY$; and a zero at $s = -1$ and scaling coefficient $K = 10$. Comment on the stability of the system. Find the natural response if $v_{out}(t = 0) = 0V$ and $v_{out}(t = 1ms) = 10V$.

## 2.2 Long questions (10 marks each)

1. In the circuit shown in Fig.2, the switch is in position $a$ till steady state is reached. At $t = 0$, the switch is moved to position $b$. Find the current through the capacitor $i_C(t > 0)$ if $v_s(t) = e^{-3t}\cos(4t)u(t)$.

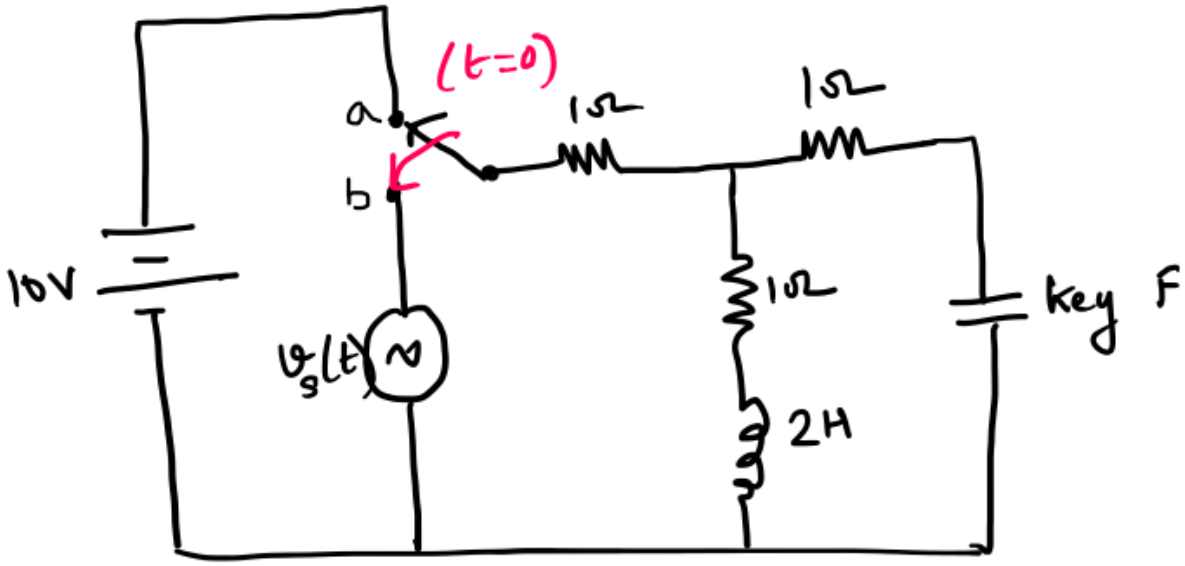


Figure 2:

2. Given the transfer function below, .

$$H(s) = \frac{\frac{1}{C}(s + \frac{R_s}{L})}{s^2 + (\frac{1}{R_pC} + \frac{R_s}{L})s + (1 + \frac{R_s}{R_p})\frac{1}{LC}}$$

where $R_p = 50\Omega$, $R_s = 0.08\Omega$, $C = 1/9F$ and $L = 1/9H$. Comment on the type of filter (low pass/high pass/band pass/ band stop). Find the bandwidth and the Q factor of the filter.

3. For the circuit shown in Fig.3, find $Y_{12}$ and $Y_{22}$ parameters.

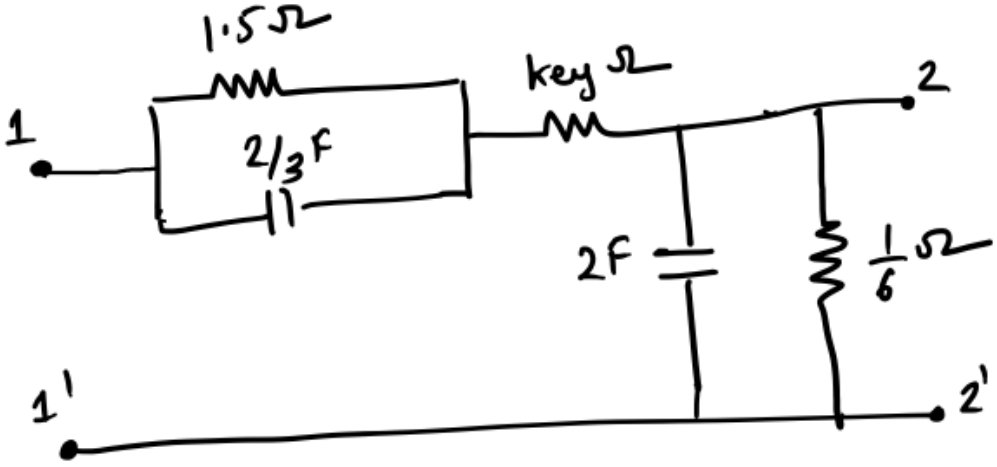


Figure 3: