

COEP Satellite Team Induction Questionnaire

February 2022 Electronics Section

General Instructions:

- A. Logical justification to answers is expected.
- B. **Final solution is not important, Your approach is!**
- C. It is **NOT** compulsory to answer all the questions but try to attempt questions even if you don't get the final answer.
- D. Use any source of information, but provide reference at the end of the solution.
- E. Physics section carries equal weightage for all the applicants.
- F. Answers should be submitted through
<https://forms.gle/TnJrUUMhoUcEbJLWA>
- G. The answers submitted on the Google form should be in a **single ".pdf"** document. A .zip file with photos/.pdf files of individual answers will **not** be accepted. You can scan / take photographs if you have handwritten some of the answers and convert it into .pdf format.
- H. Solutions in a **.txt file** will also be acceptable.
- I. Please make sure that you mention the following details on your answer sheet.
 - 1. **Name**
 - 2. **MIS**
 - 3. **Branch**
 - 4. **Gmail id** (If you don't have gmail account then please create one)
 - 5. **Contact number**
- J. Deadline for submission : **February 14 2022,11.59 p.m.**
- K. Preferred branches : E&TC, Electrical, Instrumentation and Control.
- L. Please feel free to Whatsapp or Call **Abhishek Salunke (8830723564)** or **Simran Manghwani (9307604662)** or **Hrishikesh Kembhavi (9307532602)** for any doubt.

Physics:

1) The Men In black have intercepted and decoded a suspicious alien message:

"Earth is getting suspicious of our activities. Urgently contact code zero when the bases align next fastest."

On investigating further, it is found that the message came from a planet system having two planets orbiting around their common center of mass, located in the galaxy far far away.

In this planet system planet A has mass 25 times that of planet B. The rotation time is inversely proportional to the square root of their masses. The heavier planet has a new year every 10 days and completes orbit in 5760 hrs. Both the planets have Major communication bases which can directly communicate only when both the bases and the center of mass are collinear.

After How much time the Men in black will intercept the next message ?

One year = Time for the planet to orbit around the center of mass

One day = Time for the planet to rotate around itself once

2) At instant $t = 0$, a rod of mass m , length l is kept vertically on a completely frictionless surface and released.

a) Describe the motion of the following points with respect to your frame of reference as well as with respect to the center of mass frame of reference:

i) Lowest point

ii) Center of mass

iii) Highest point

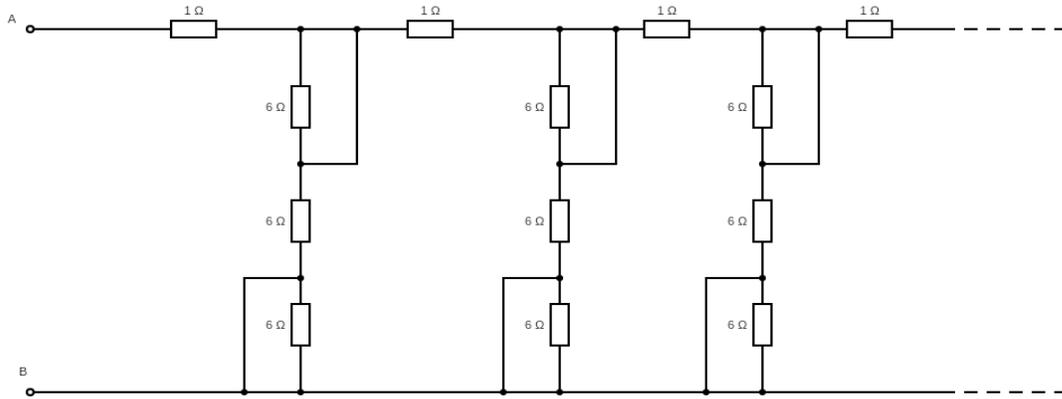
b) Is the motion combined with rotation and translation ?

c) Is there any movement of the lowest point in the vertical direction ?

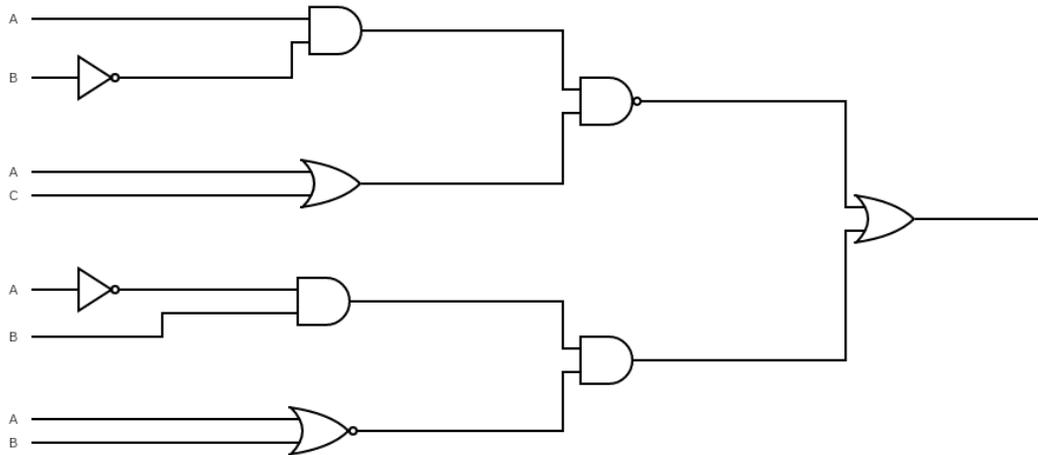
d) Is the center of mass Frame inertial?

Electronics:

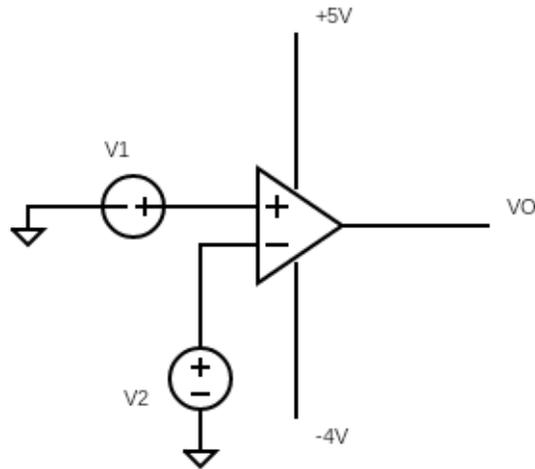
1) Find Equivalent resistance between A and B.



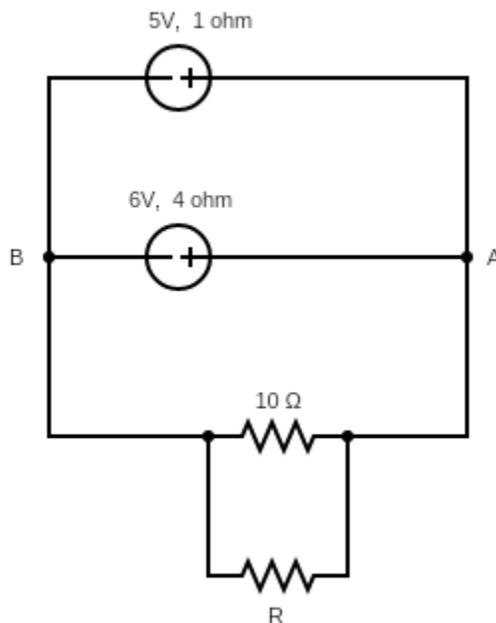
2) Simplify the given logic gate circuit diagram. Design the simplified circuit using NAND gates only.



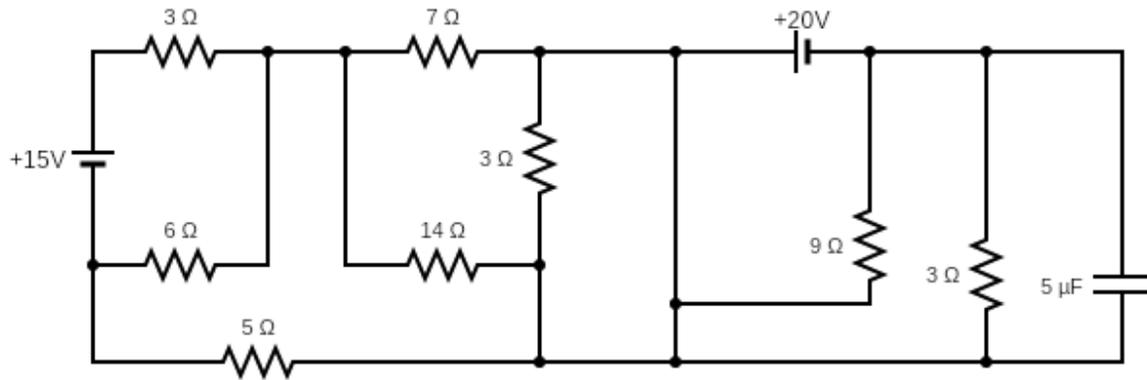
- 3) Find the value of V_o and plot the output waveform in the following cases if the open loop gain of the op-amp is 10^6
- a. $V_1=10 \mu\text{V}$, $V_2=6 \mu\text{V}$ b. $V_1=2 \mu\text{V}$, $V_2=8 \mu\text{V}$



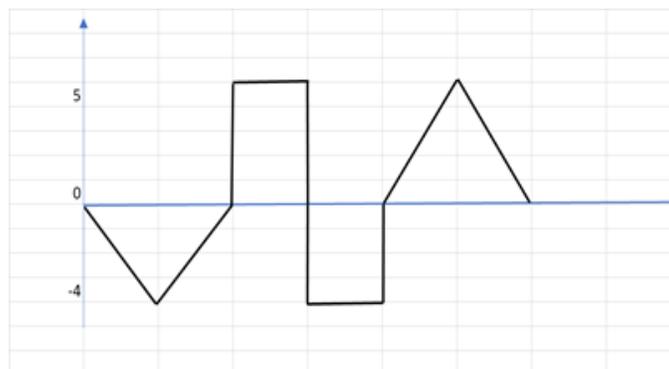
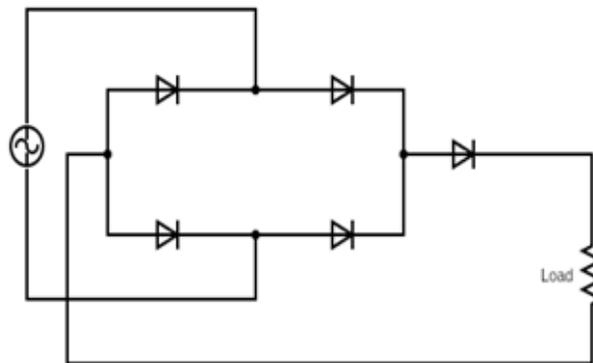
- 4) Figure below shows voltage sources with their internal resistance values. What should be the value of R for maximum power dissipation across AB .



5) Find the energy stored in the capacitor.

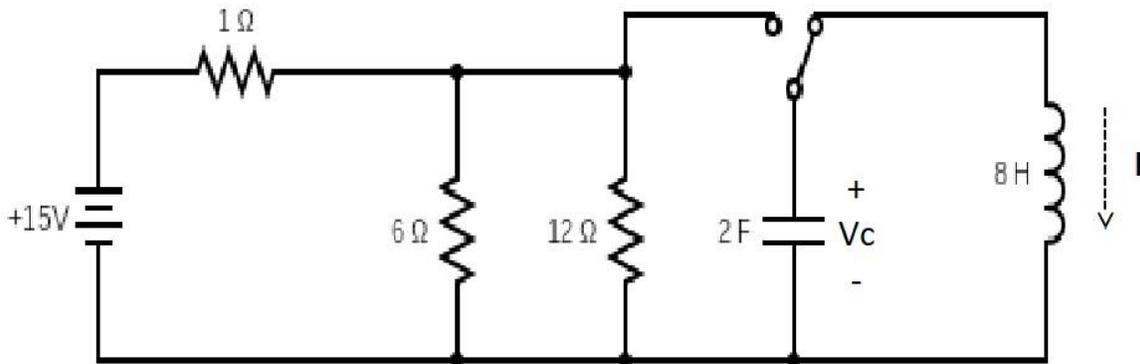


6) Consider the circuit given below consisting of 5 **silicon diodes**. An input voltage source is applied between the two terminals as shown. Similarly, a load is connected across the other two terminals of the assembly (shown in the figure).



The input voltage consists of triangular and square waveforms (shown in the figure with their amplitudes). Draw a rough sketch of the voltage waveform across the load. Also mark the amplitudes. Justify your answer.

7)



Switch was kept to the left for a very long time. At $t=0$, the switch was turned to the right. Find $I(t)$ and $V_c(t)$ (as functions of time). Also plot the waveform of the current $I(t)$ after $t>0$. Take the indicated direction of the current positive.
Hint : Find the differential equation for the current for $t>0$.

8) Capacitor has unequal area of two plates, A_1 and A_2 , distance between two plates is 'd'. A capacitor is having a variable dielectric constant as a function, $k=k_1+k_2/d$ (y). Assuming that $|Q|$ charge is on both plates and electric field E is taken to be uniform. Calculate the capacitance in the following conditions. (Think of overlapping concept of area in the capacitors)

- 1) $A_1 \gg A_2$
- 2) $A_1 > A_2$

9) A simple machine is made up of two hollow metallic cylinders of different radii and the same height. The arrangement is such that one cylinder is placed inside the other. In the working cycle of the machine, the radius of the inner cylinder reduces to a certain value and then increases back to its original value. The radius of the outer cylinder does not change. Unfortunately, there is no equipment in the lab to measure any kind of mechanical properties. The lab has all the equipment to measure the electrical properties of the cylinders. How would you use your knowledge of passive electrical components to calculate the change in the volume of the inner cavity of the machine?

10) Find the energy stored in each inductor at steady state and current through each branch.

