ELECTRONICHE 2020 PRELIMS

UG II & III – MORNING SESSION

Section I (For every question, 2 mark for correct answers, -1 for wrong answers) (2x5)

1. Today is the 7th of March, 2020. On what day will this date come next year?
   (A) Monday
   (B) Tuesday
   (C) Thursday
   (D) Sunday

2. If I run at 1.4 times my usual rate, I reach my destination 9 minutes too early. How long do I take if I run at my normal rate?
   (A) 32 mins 20 secs
   (B) 25 mins
   (C) 31 mins 30 secs
   (D) 23 mins 30 secs

3. A beats B by 31 metres and C by 18 metres in a 200 metres race. By how many metres will C beat B ?
   (A) 13 metres
   (B) 14 metres
   (C) 18.5 metres
   (D) 24.5 metres

4. The income of Amala is 20% more than that of Bimala and 20% less than that of Kamala. If Kamala's income goes down by 4% and Bimala's goes up by 10%, then the percentage by which Kamala's income would exceed Bimala's is nearest to-
   (A) 31
   (B) 28
   (C) 32
   (D) 29

5. The number of common terms in the 2 sequences: 15,19,23,27,…,415 and 14,19,24,29,…,464 is
   (A)18
   (B)19
   (C)21
   (D)20

Section II (For every question, 2 marks for correct answers, -0.5 for wrong answers) (2x20)

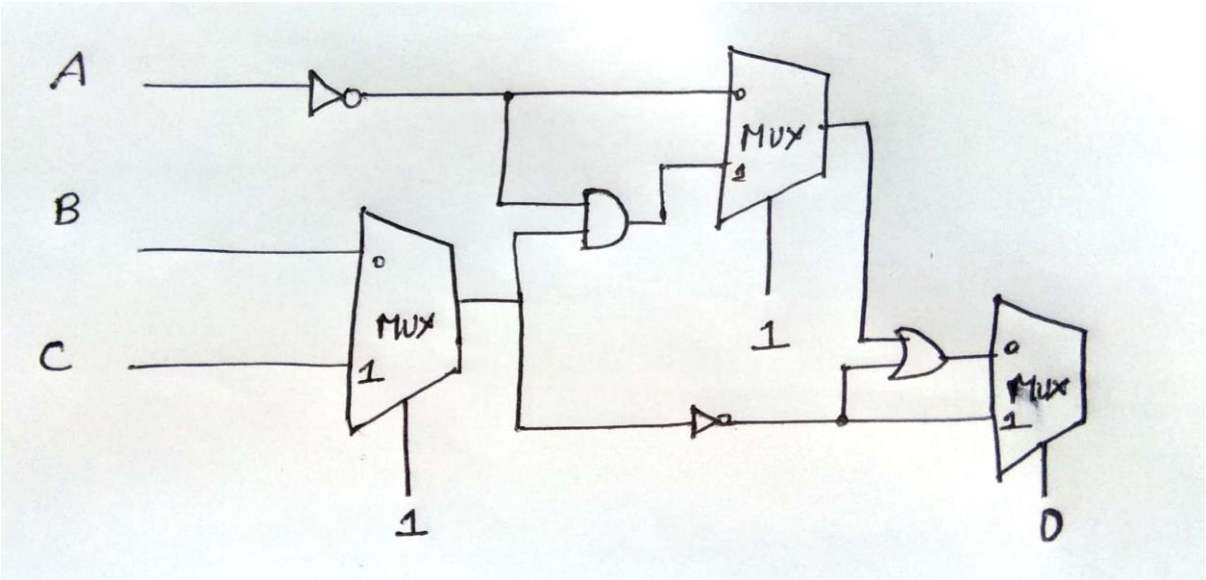
1. A traffic system has 3 states- RED, GREEN and YELLOW. A 3 flip-flop One-Hot arrangement controls the current state. The RED signal is on for 20 seconds, the GREEN for 30 seconds and the YELLOW for 10 seconds. A clock signal of frequency 0.2 Hz is given and infinite flip-flops are available. What is the minimum number of flip-flops required to implement the circuit ?

2. Design a 010 over-lapping signal detector with 11 as the state reset.

3. The output Y of a 2-bit comparator is logic 1 whenever the 2-bit input A is greater than the 2-bit input B. The number of combinations for which the output is logic 1, is

   (A) 4
   (B) 6
   (C) 8
   (D) 10

4. In the following circuit, NOT gates have a gate delay of 10 ns, AND gates of 15 ns, OR gates of 12 ns and MUX have a delay of 20 ns. How much time will the inputs at A,B and C take to be propagated to the o/p of the MUX with address line tied to 0 ?



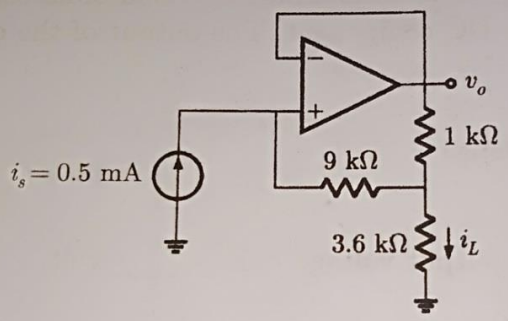
5. The correct way to draw AC+B is by using ___ AND gates only. Explain.

6. Design a circuit with two inputs that can behave as a buffer and an inverter if the inputs are adjusted. Show how you reached the conclusion.

7. A gate is nothing but an IC designed by incorporating transistors. Thus, most of the interrupts used are always active ____ (low/high). Give possible reason.

8. We generally have used the 74 series of IC always. Can you tell the difference between 7476 and 74LS76? [Hint: Both of them are JK flip flops, have 16 pins, LS means Low power Schottky]

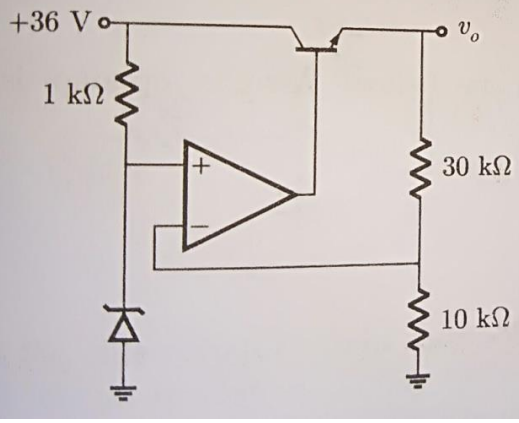
9. An ideal op-amp circuit is shown in figure



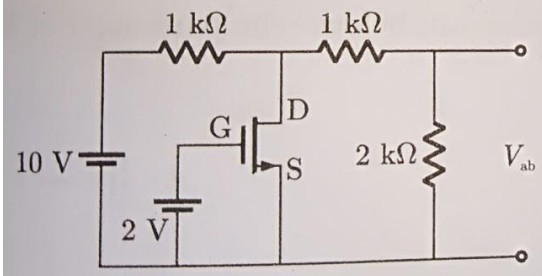
Current i_L is _____ mA.

In above circuit, input impedance (Z_{in}) seen by the current source is _____ kΩ

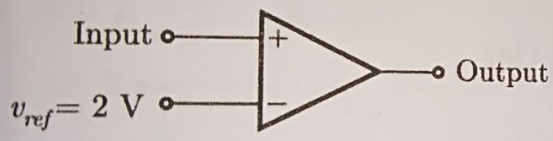
10. In the op-amp series regulator circuit shown below, $v_z = 6.2$ V, $V_{BE} = 0.7$ V and $\beta = 60$. The output voltage v_o is _____ volts.



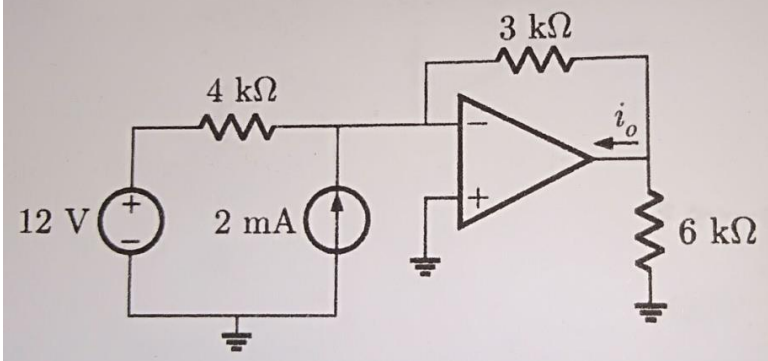
11. Assume that the n-channel MOSFET shown in the figure is ideal, and that its threshold voltage is $+1.0$ V the voltage V_{ab} between nodes a and b is _____ volts.



12. If the input to the following ideal comparator is a sinusoidal signal of 8 V (peak to peak) without any DC component. The output of the comparator has a duty cycle of

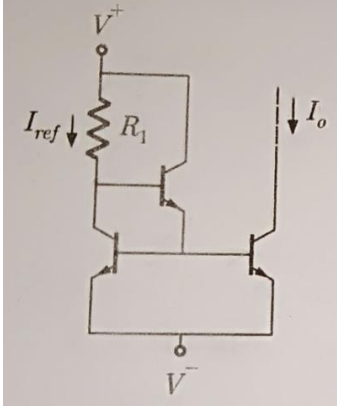


13. For the circuit shown below the value of i_o is _____ mA.



14.

Consider the base three transistor current source in figure below. Assume all transistor are matched with finite gain and early voltage $V_A = \infty$. The expression for I_o is



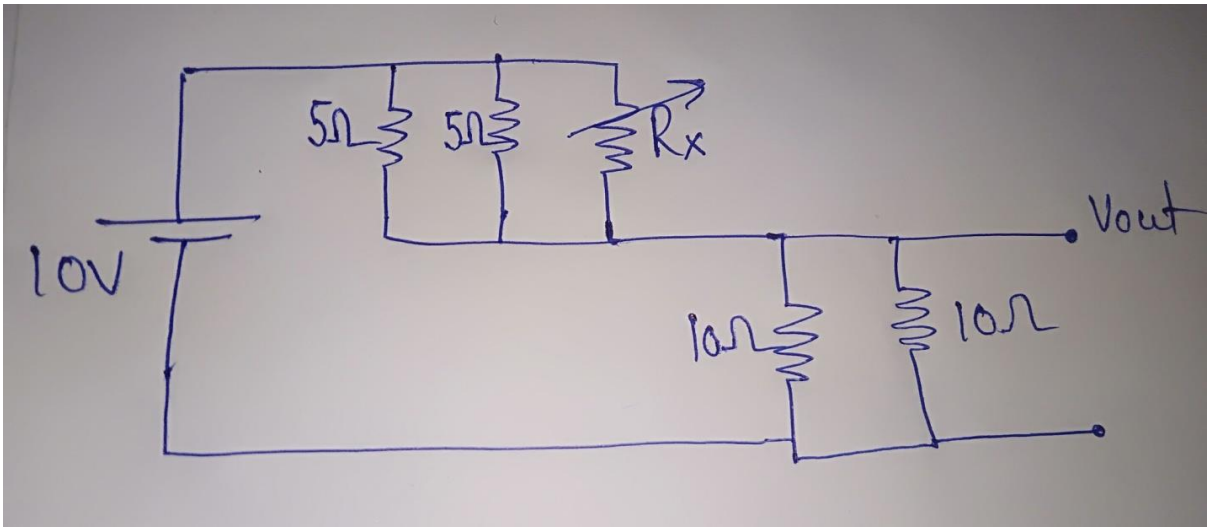
(A) $\dfrac{I_{ref}}{1+\frac{2}{1+\beta}}$

(B) $\dfrac{I_{ref}}{1+\frac{1}{2+\beta}}$

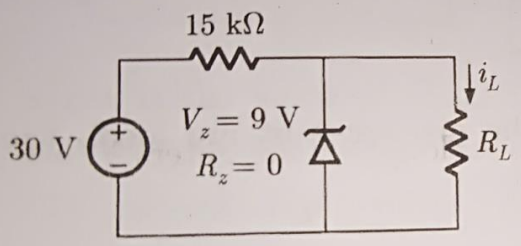
(C) $\dfrac{I_{ref}}{1+\frac{2}{\beta(1+\beta)}}$

(D) $\dfrac{I_{ref}}{1+\frac{1}{\beta(2+\beta)}}$

15. For the given circuit below, Resistance Rx is variable and can vary from 0 to 200 ohms. Find out the value of Rx such that maximum power flows through the 10 ohm resistor.



16. In the voltage regulator circuit shown below the maximum load current i_L that can be drawn is _____ mA.



17. Consider a triangular wave with amplitude = ±1V and time period = 5 x 10^{-4} s. For a frequency sensitivity of 2π x 10^3 rad. V^{-1} and a carrier frequency of 100kHz, the maximum and minimum frequency of the FM modulated wave (in Hz) are
    A) 1.01 x 10^3 and 9.9 x 10^3 respectively.
    B) 1.10 x 10^5 and 9.9 x 10^5 respectively.
    C) 1.01 x 10^5 and 9.9 x 10^4 respectively.
    D) 1.01 x 10^5 and 9.9 x 10^5 respectively.

18. The Nyquist sampling rate for the signal
    $s(t) = \sin\left(\frac{500\pi t}{\pi t}\right) \times \sin\left(\frac{700\pi t}{\pi t}\right)$
    A) 400Hz.
    B) 600Hz.
    C) 1200Hz.
    D) 1400Hz.

19. The Fourier series of a real periodic function has only
    P. Cosine terms if it is even
    Q. Sine terms if it is even
    R. Cosine terms if it odd
    S. Sine terms if it is odd
    Which of the above statement are correct?
    A) P and S.
    B) P and R.
    C) Q and S.
    D) Q and R.

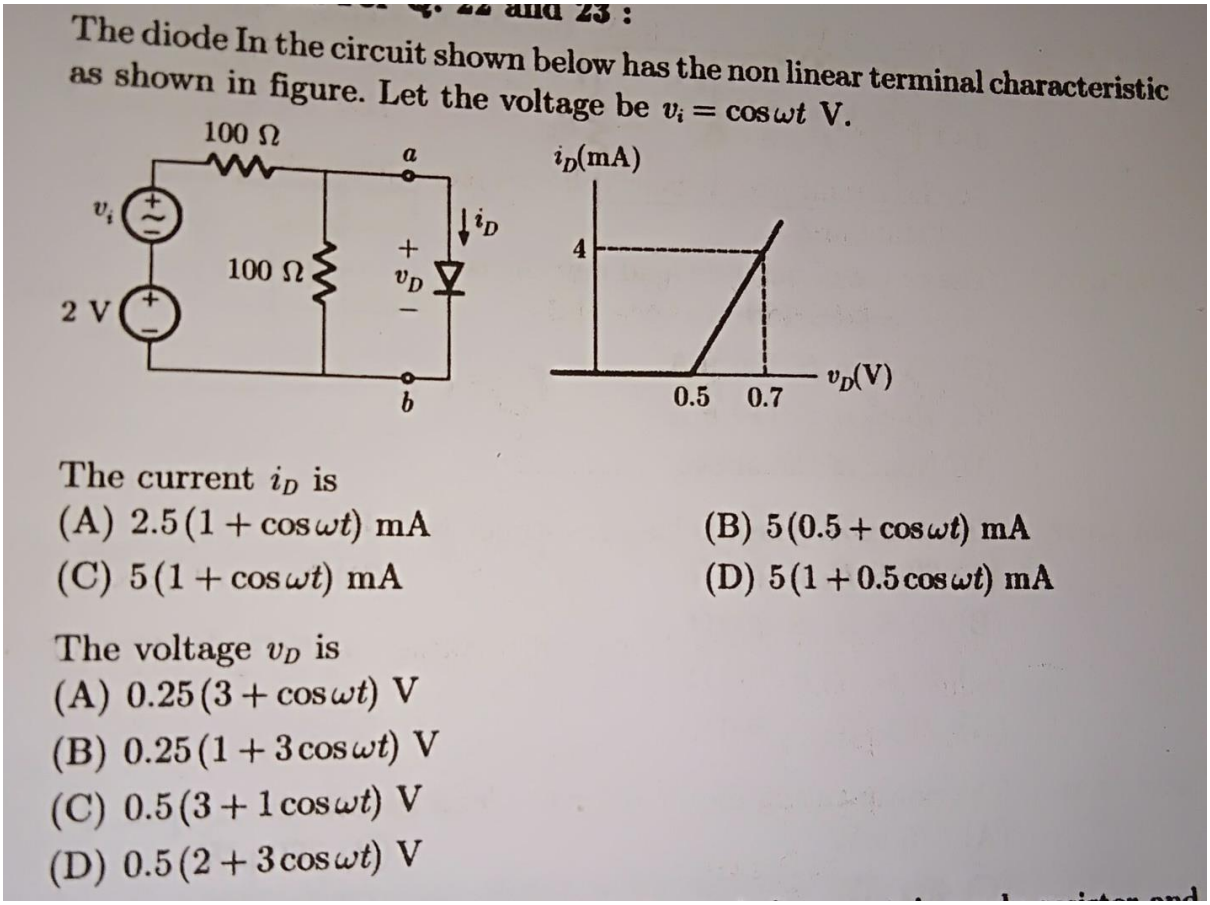
20. The result of the convolution $x(-t) * \delta(-t - t_0)$ is
    A) $x(t + t_0)$.
    B) $x(t - t_0)$.
    C) $x(-t + t_0)$.
    D) $x(-t - t_0)$.

Section III (For every question, 5 marks for correct answers, no negatives)

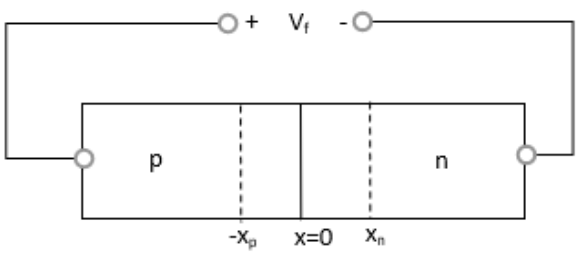
1. Design a T/4 delay circuit with flipflops. Consider input has 50% duty cycle.

2. 4 students A, B, C and D are sitting for an exam. There is ONE question in the paper and SUCCESS of the entire CLASS depends on three of the students giving the correct answer. Person A is sitting isolated in one corner of the room where no one can see his paper. Persons B, C, and D are however sitting in consecutive benches with B in the first Bench, C in the second bench and D in the third bench. Persons B and D are honest students and they don't cheat. However, C is a blatant cheater who can see both the answers of B and C and is wise enough to know which is the correct one and copies it.

   Find the expression for the success of the class by Kmap method. Use symbols A, B, C and D only and draw the circuit. Specify all the cases [Success, Don't care, forbidden and Failure]

3. 

4. A Silicon step junction at 300K has uniform impurity doping concentrations of $5 \times 10^{15}\,cm^{-3}$ acceptor atoms and $10^{15}\,cm^{-3}$ donor atom. The cross-sectional area is $10^{-4}cm^{-2}$. Let $\tau_{n0} = 0.4\mu s$, $\tau_{p0} = 0.1\mu s$, $D_n = 25cm^2s^{-1}$ and $D_p = 10cm^2s^{-1}$.



a) Find the ideal reverse saturation current due to electrons.
b) Find the electron concentration at $x = -x_p - 0.5L_n$ for $V_f = 0.5V_0$.
c) Find the electron concentration at $x = x_n + 0.5L_p$ for $V_f = 0.5V_0$.
Given $n_i = 1.5 \times 10^{10} cm^{-3}$ and V_0 is the junction potential

Section IV (OPTIONAL SECTION for tie-breaks) (For every question, 2 marks for correct answers, -0.5 for wrong answers) (2x5)

1. A microcontroller has 32 address lines. Which memory address is located at line number 55 of page 253 ?

2. If $CS=A_{15}`A_{14}A_{13}$ is used as the chip select logic of a 4K RAM in a 8085 system, then its memory range will be ?

   (A) 3000-3FFFH
   (B) 7000-7FFFH
   (C) 5000-5FFFH & 6000-6FFFH
   (D) 6000-6FFFH & 7000-7FFFH

3. Can Circular convolution be used to get the output sequence from Linear Convolution? Explain.

4. Why is 2's complement preferred over 1's complement although the algorithm is shorter for 1's complement?

5. Is correlation nothing but convolution with some assumptions? If not, explain why