KATHMANDU UNIVERSITY
End Semester Examination
March, 2025

Marks Scored:

Level : B.Sc.
Year : II

Course : PHYS 201
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date : 07 MAR 2025

SECTION "A"
[20Q. × 1 = 20 marks]

Choose and tick the most appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings.

1. Norton's theorem replaces a complicated circuit facing a load with an
   a. Ideal voltage source and parallel resistor
   b. Ideal current source and parallel resistor
   c. Ideal voltage source and series resistor
   d. Ideal current source and series resistor

2. At room temperature, an intrinsic silicon crystal acts approximately like
   a. An insulator b. A conductor c. A battery d. A piece of copper wire

3. A trivalent impurity is added to silicon to create
   a. germanium b. an n-type semiconductor
   c. a p-type semiconductor d. a depletion region

4. How much load current is there in Figure A-1 with the second approximation?

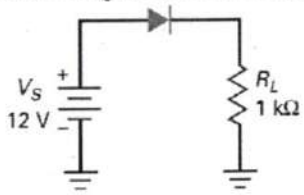

Figure A-1

   a. 0 b. 11.3 mA c. 12 mA d. 25 mA

5. The width of a diode's depletion layer will decrease when the diode is
   a. Forward biased b. First formed c. Reverse biased d. Not conducting

6. Which diode is specifically designed to function as a voltage-controlled capacitor by varying its capacitance with changes in the applied reverse bias voltage?
   a. Zener Diode b. Schottky Diode c. Varactor Diode d. Light Emitting Diode

7. For normal operation of the transistor, the collector diode has to be
   a. Forward biased b. Reverse biased
   c. Nonconducting d. Operating in the breakdown region

8. In class A amplifier, the collector current, I_C, flows for
   a. 360^0 of the ac input cycle. b. 120^0 of the ac input cycle.
   c. 180^0 of the ac input cycle. d. 60^0 of the ac input cycle.

9. The silicon transistor in the base bias circuit shown in FigureA-2 has a β of 100. The equation of the load line is

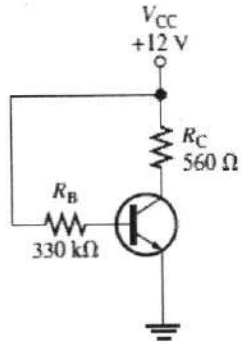

Figure A-2

a. $I_C = -\frac{1}{100}V_{CE} + \frac{12}{100}$

b. $I_C = \frac{1}{560}V_{CE} + \frac{12}{560}$

c. $I_C = -\frac{1}{560}V_{CE} + \frac{12}{560}$

d. $I_C = -\frac{1}{330}V_{CE} + \frac{12}{330}$

10. The value of drain to source voltage, V_{DS}, at which the drain current, I_D, levels off is called

a. cutoff voltage, $V_{GS(off)}$.
b. pinch-off voltage, V_P.
c. breakdown voltage, V_{BR}.
d. threshold voltage, $V_{GS(th)}$.

11. The tail current of a diff amp is

a. Half of either collector current
b. Equal to either collector current
c. Two times either collector current
d. Equal to the difference in base currents

12. The Wien-bridge oscillator's positive feedback circuit is

a. an RL circuit
b. an LC circuit
c. a voltage divider
d. a lead-lag circuit

13. What is the Boolean equation for the output of Figure A-3?

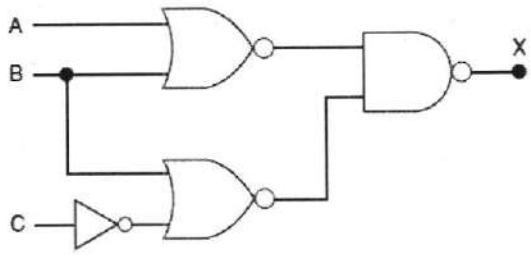

Figure A-3

a. $\overline{(A+B)} \cdot \overline{(B+\bar{C})}$.

b. $\overline{\overline{(A+B)} + \overline{(B+\bar{C})}}$.

c. $\overline{\overline{(A \cdot B)} + \overline{(B \cdot \bar{C})}}$.

d. $\overline{\overline{(A+B)} \cdot \overline{(B+\bar{C})}}$

14. What is the 2's complement representation of the binary number 0011 0101?

a. 1100 1010 b. 1100 1011 c. 0011 0101 d. 1100 1100

15. Which of the following truth table is TRUE for a circuit shown in Figure A-4?

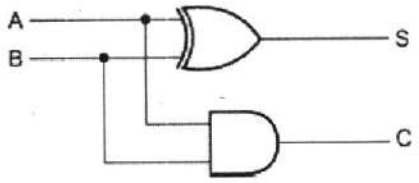

Figure A-4

a.

A	B	C	S
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	0

b.

A	B	C	S
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

c.

A	B	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

d.

A	B	C	S
0	0	0	0
0	1	1	1
1	0	1	1
1	1	0	0

Fill in the blanks with most appropriate answer:

16. If line frequency is 60 Hz, the output frequency of a bridge rectifier is _____.

17. The collector current is1.5 mA . If the current gain is 50, the base current is _____.

18. A certain op-amp has an open-loop differential voltage gain of 100,000 and a common-mode gain of 0.2. The CMRR (in decibels) is _____.

19. In a certain oscillator, $A_v = 50$. The attenuation of the feedback circuit must be _____.

20. The binary equivalent of decimal 555 is _____.

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SECTION "B"
[5Q × 4 = 20 marks]

Attempt ALL questions.

1. Find the Thevenin equivalent circuit to the left of terminals A-B in Figure B-1. Using Thevenin's theorem, calculate the load current for the load resistance $R_L = 2\ \Omega$.

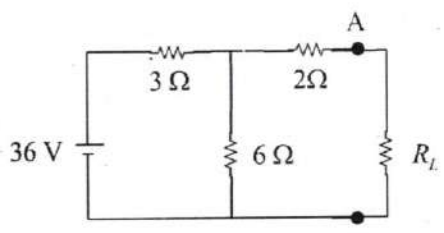

Figure B-1

2. Define doping in the context of semiconductors. How does doping lead to the formation of an n-type semiconductor? What are the key differences between intrinsic and extrinsic semiconductors?

OR

What is a Zener diode? Draw a basic Zener diode voltage regulator circuit and explain how it maintains a stable output voltage under varying input voltage and load current conditions.

3. Sketch and describe the structure of an n-channel enhancement MOSFET. Explain its working principle, and then draw a typical set of static drain characteristics for an n-channel enhancement MOSFET.

4. Derive an accurate formula for the dc emitter current in a voltage-divider biased Bipolar Junction Transistor (BJT) circuit.

5. Provide the truth table and Boolean expression for a two-input NOR gate. Additionally, demonstrate how a two-input NOR gate can be used to implement the fundamental logic gates: AND, OR, and NOT.

OR

What is the binary equivalent of the octal number 553? Add these 8-bit binary numbers: 0101 0111 and 0011 0101, and show the corresponding hexadecimal value.

P.T.O.

SECTION "C"
[5Q × 7 = 35 marks]

6. Which type of full-wave rectifier has the greater output voltage for the same input voltage and transformer turns ratio? Consider the center-tapped full-wave rectifier circuit in Figure C-1.

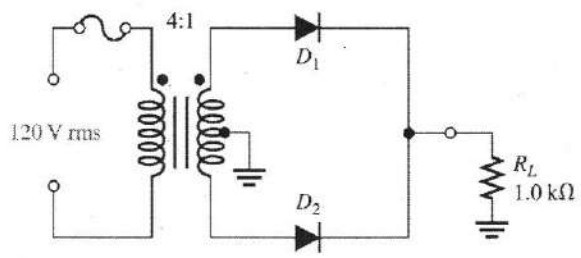

Figure C-1

a. Draw the output voltage waveform.
b. What is the total peak secondary voltage?
c. Find the peak voltage across each half the secondary?
d. Sketch the voltage waveform across R_L.
e. What is the dc diode current?
f. What is the PIV for each diode?

7. Define an oscillator and state the conditions required for a circuit to oscillate. Draw the circuit diagram of a Hartley oscillator, provide its oscillation frequency formula, and explain the fundamental difference between Hartley and Colpitts oscillators.

OR

Draw the Wien-Bridge oscillator circuit and provide its formula for the resonant frequency. Consider the circuit in Figure C-2. Assume $R_1 = R_2 = R_3 = 10^4\,\Omega$ and $C_1 = C_2 = C_3 = 10^{-9}\,\text{F}$

a. Determine the value of R_f necessary for the circuit in Figure C-1 to operate as an oscillator.
b. Determine the frequency of oscillation.

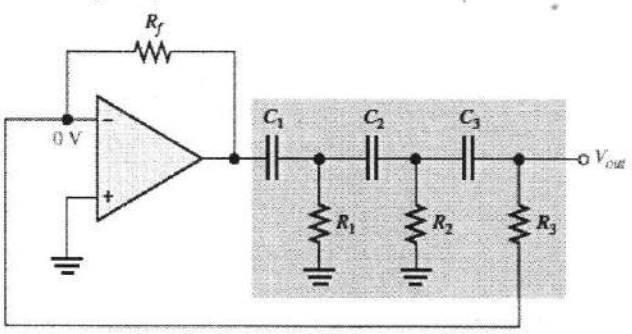

Figure C-2

8. Draw the circuit diagram of a CE amplifier, including its dc and ac equivalent circuits. Derive the expressions for current gain, voltage gain, and power gain. Explain the reason for phase inversion between input and output.

OR

Draw the circuit diagram of an RC-coupled class A amplifier. Derive the expression to show that the maximum possible efficiency for any RC-coupled class A amplifier is 8.33%.

9. Define an operational amplifier (op-amp) and list its ideal characteristics. Derive the expression for the closed-loop voltage gain of an inverting amplifier. Additionally, describe the working principle of an op-amp differentiator circuit, including its input-output relationship.