Hour Examination #2

1) Write your official:
   Last Name (use capital letters): _______________________________________
   First Name (use capital letters): _______________________________________
   NetID: _____________________________________________________________
   UIN: ______________________________________________________________

2) Fill in the Orange bubble sheet with all the information requested:
   a. LAST NAME, FIRST INITIAL example: SCHMITZ C
   b. STUDENT NUMBER (UIN) example: 678912345
   c. SECTION (9am = 444, 10am = 111, 1pm = 222, 2pm = 333)
   d. NETWORK ID (NetID) example: cdschmit
   e. Also, fill out the hand-written center of the sheet with course, instructor, section and your signature.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

A. Write or print clearly in this exam booklet for your own benefit. Circle the correct answer within the exam booklet and then mark it on the orange bubble sheet. You may not argue for points because you marked one answer in the exam and another on the bubble sheet, so be careful when marking your answers.

B. All problems are equally weighted.

C. Your grade will be determined based on the answers submitted on your bubble sheet. Submit both the bubble sheet AND the complete exam booklet.

NO CALCULATORS PERMITTED. Students caught cheating on this exam will earn a grade of F for the entire course. Other penalties may include suspension and /or dismissal from the university.

I have read and acknowledge the above statements. Furthermore, I promise not to give or receive help on this or any other exam.

___________________________________________
Signature
You have TEST FORM:

A

Please enter this in the lower right corner of the orange bubble sheet in the location marked TEST FORM.
1. Assuming an offset ideal model, what is the current, \( I \), if the diode has the turn on voltage \( V_{ON} = 0.7 \, V \)?

   a. 3.5 mA  
   b. 11.5 mA  
   c. 15 mA  
   d. 18.5 mA  
   e. 35 mA

   ![Diode Circuit Diagram]

2. If the light-emitting diode (LED) has the turn on voltage \( V_{ON} = 2 \, V \), what is the resistance \( R \) needed to set the electrical power consumed by the LED to 100 mW (assuming the offset ideal model)?

   a. 20 \( \Omega \)  
   b. 40 \( \Omega \)  
   c. 60 \( \Omega \)  
   d. 80 \( \Omega \)  
   e. 100 \( \Omega \)

   ![LED Circuit Diagram]

3. If \( V_{ON} = 0.7 \, V \) for both diodes, what is the minimum voltage \( V_2 \) which will turn on the diode on the right?

   a. 0.75 V  
   b. 1.1 V  
   c. 1.45 V  
   d. 1.8 V  
   e. 2.9 V

   ![Diode Circuit Diagram with V2 Voltage Source]
4. What are the minimum and maximum values of $V_{out}$ assuming the offset ideal model for a diode with $V_{on} = 0.7 \, V$ for the input signal shown below?

\[ 3\cos(1000\pi t) \]

- a. minimum -3 V, maximum 3 V
- b. minimum -3 V, maximum 0.7 V
- c. minimum -3 V, maximum 1.4 V
- d. minimum 0.7 V, maximum 3 V
- e. minimum 1.4 V, maximum 3 V

5. How many of the light-emitting diodes are ON in the diagram below, assuming an offset ideal model with $V_{ON} = 2 \, V$?

\[ 7.5 \, V \]

- a. 1
- b. 2
- c. 3
- d. 4
- e. 6
6. In an active region of operation, if the base current is fixed, a BJT CE emitter junction can be modeled as a

   a. Thevenin equivalent
   b. Variable resistor
   c. Voltage source
   d. Current source
   e. Diode

7. If we bias the transistor such that $V_{CC} = 9.2 \, \text{V}$, $R_B = 10 \, \text{k}\Omega$ and $R_C = 500 \, \Omega$ what is the output voltage, $V_{CE}$, when the input, $V_i = 1.2 \, \text{V}$?

   a. 9.0 V
   b. 6.7 V
   c. 3.2 V
   d. 2.5 V
   e. 0.2 V

8. If we bias the transistor such that $V_{CC} = 9.2 \, \text{V}$, $R_B = 10 \, \text{k}\Omega$ and $R_C = 500 \, \Omega$ what is the minimum input voltage, $V_i$, for which output voltage reaches saturation, i.e. $V_{CE} = 0.2 \, \text{V}$?

   a. 0.7 V
   b. 1.8 V
   c. 2.5 V
   d. 4.3 V
   e. 9.2 V
9. What is the power that is dissipated by the transistor if \( i_B = 0.7 \, mA \)?

\[
\beta = 100 \\
V_{CE,\text{sat}} = 0.2 \, V \\
V_{BE,\text{on}} = 0.7 \, V
\]

- a. Approximately 0.5 mW
- b. Approximately 14 mW
- c. Approximately 210 mW
- d. Approximately 490 mW
- e. Approximately 700 mW

10. Given the BJT IV characteristic with the load line provided, and assuming \( V_{BE,\text{on}} = 0.7 \, V \), what is the output voltage, \( V_o \), when \( V_i = 1.7 \, V \), in the circuit below?

**HINT:** \( R_B = 40 \, k\Omega \), while \( V_{CC} \) and \( R_C \) can be found from the load line.

\[
\beta = 100 \\
V_{CE,\text{sat}} = 0.2 \, V \\
V_{BE,\text{on}} = 0.7 \, V
\]

- a. 1 V
- b. 2 V
- c. 3 V
- d. 4 V
- e. 5 V
11. Given the BJT below biased with $V_{CC} = 12 \, V$, $R_C = 200 \, \Omega$, $R_B = 1 \, k\Omega$, what is/are the regime(s) of operation of the BJT if the input voltage is given by $V_i(t) = 1 + 0.5\cos(2000\pi t)$?

a. Active only  
b. Cut-off (Off) and Active  
c. Cut-off (Off) and Saturation  
d. Active and Saturation  
e. Cut-off (Off), Active, and Saturation

12. If the coordinates biasing of the BJT inverter is given by $V_{CC} = 12 \, V$, $R_C = 200 \, \Omega$, $R_B = 1 \, k\Omega$, what is the slope of the transfer characteristics, given by $G = \frac{V_{o2}-V_{o1}}{V_{i2}-V_{i1}}$?

a. -20  
b. -17  
c. -15  
d. -12  
e. -10
13. Which of the following output columns correctly represents the output of the logic gate circuit below for inputs $A$ and $B$?

- a. $Z_1$
- b. $Z_2$
- c. $Z_3$
- d. $Z_4$
- e. $Z_5$

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<tr>
<th>Inputs</th>
<th>Output Choices</th>
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14. Why is the cMOS logic circuit below improperly constructed?

- a. The pMOS transistors should be in the lower part of the circuit
- b. The output $Z$ is independent of inputs $A$ and $B$
- c. The output $Z$ is undefined when $A=0$ and $B=0$
- d. The output $Z$ is undefined when $A=0$ and $B=1$
- e. The power source can be mistakenly shorted to ground
15. If a chip with 50,000,000 transistors, a clock rate of 2 GHz and V_{DD} of 3 V is dissipating 90 W with a 10% activity rate, what is the switching capacitance of the transistors? Note that 1 GHz is 10^9 Hz and that 1 fF is 10^{-15} F.
   a. 1 fF
   b. 2 fF
   c. 3 fF
   d. 4 fF
   e. 5 fF

16. How many possible bit sequences can a 6-bit register hold?
   a. 16
   b. 32
   c. 36
   d. 64
   e. 128

17. If the RMS voltage of thermal noise added to a sinusoidal signal is one tenth of the RMS voltage of the waveform itself, the ratio of signal power to noise power is
   a. 1/100
   b. 1/10
   c. 1
   d. 10
   e. 100

18. What is the highest frequency in the waveform given by
   \( v(t) = 3 + 2 \cos(1000 \pi t) - \sin(3000 \pi t) \)
   a. 500 Hz
   b. 1000 Hz
   c. 1500 Hz
   d. 3000 Hz
   e. 4000 Hz
19. Which of the following SD cards is big enough hold 200 uncompressed images, but too small to hold 400 images, if each image has about 16 million pixels with 36 bits stored per pixel? (Assume 1 GB is $10^9$ Bytes)
   a. 4 GB
   b. 8 GB
   c. 16 GB
   d. 32 GB
   e. 64 GB

20. If we want to digitize speech with the frequency content that is between 100 Hz and just below 6 kHz, the minimum sampling rate we must use is
   a. 3 kHz
   b. 6 kHz
   c. 8 kHz
   d. 9 kHz
   e. 12 kHz

21. If we want to quantize a voltage signal which can range between 0 and 6 V with the level spacing of less than 0.05 V, the minimum number of bits per sample that we should use is
   a. 6
   b. 7
   c. 8
   d. 9
   e. 10

22. If a 4-bit quantizer rounds the analog voltage to the nearest quantization level, the maximum quantization error is about what percent of the range (defined as the difference between the highest and lowest quantization levels)?
   a. 1%
   b. 2%
   c. 3%
   d. 4%
   e. 6%
23. Which of the following filters will smooth out fast transitions in a signal?
   a. Low-pass filter
   b. High-pass filter
   c. Median filter
   d. Filter that passes all frequencies
   e. Filter that blocks all frequencies

24. If the digital filter output is defined as \( y[n] = \frac{x[n]-x[n-1]}{2} \) and the input sequence is given by \( x[n] = \{2.5, 2.7, 2.5, 3.3, 3.8, 4.0, 3.5, 3.7\} \) for \( n = 0 \) to 7, the maximum value of \( y[n] \) will occur when \( n \) is
   a. 2
   b. 3
   c. 4
   d. 5
   e. 7

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25. Which row correctly represents the output of the filter given by \( y[n] = median(x[n]; x[n-1]; x[n-2]) \)

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