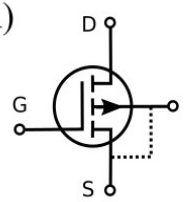
BME 362 Biomedical Instrumentation Design Exam #1 Spring 2017 Name: _____

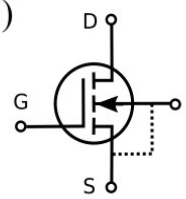
Open book/note. 10 points for each question (10 x 10 = 100 points).

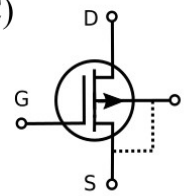
1. ( ) The forward bias voltage of a silicon p-n junction is (A) 0.20 V, (B) 0.45 V, (C) 0.65 V, (D) 1.2 V, (E) none of the above.

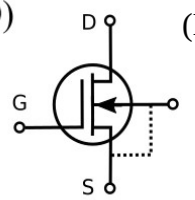
2. ( ) Which of the following diodes can be used as a heat engine for thermoelectric cooling? (A) Zener diode, (B) Schottky diode, (C) Peltier diode, (D) tunnel diode, (E) none of the above.

3. ( ) Which of the following is the circuit symbol for an enhancement-type p-channel MOSFET?

(A) 

(B) 

(C) 

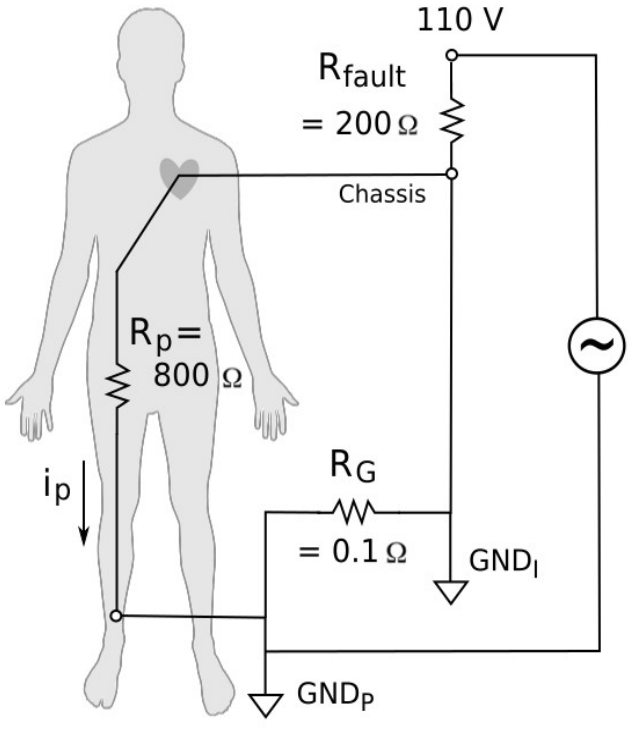
(D) 

(E) none of the above.

4. ( ) In medical instrumentation, which of the following devices is <u>not</u> useful for the electrical isolation of the critical front-end area connected to the patient? (A) signal transformer, (B) optocoupler, (C) digital-to-analog converter, (D) DC-to-DC converter, (E) none of the above.

5. ( ) The ground fault circuit interrupter (GFCI) can reduce the risk of electrical hazards due to leakage currents. The amount of detectable leakage currents and the time for the GFCI to disconnect should be, respectively, (A) 1–5 mA and <50 ms, (B) 5–30 mA and <300 ms, (C) 50–100 mA and <500 ms , (D) 1-2A and <1 s, (E) none of the above.

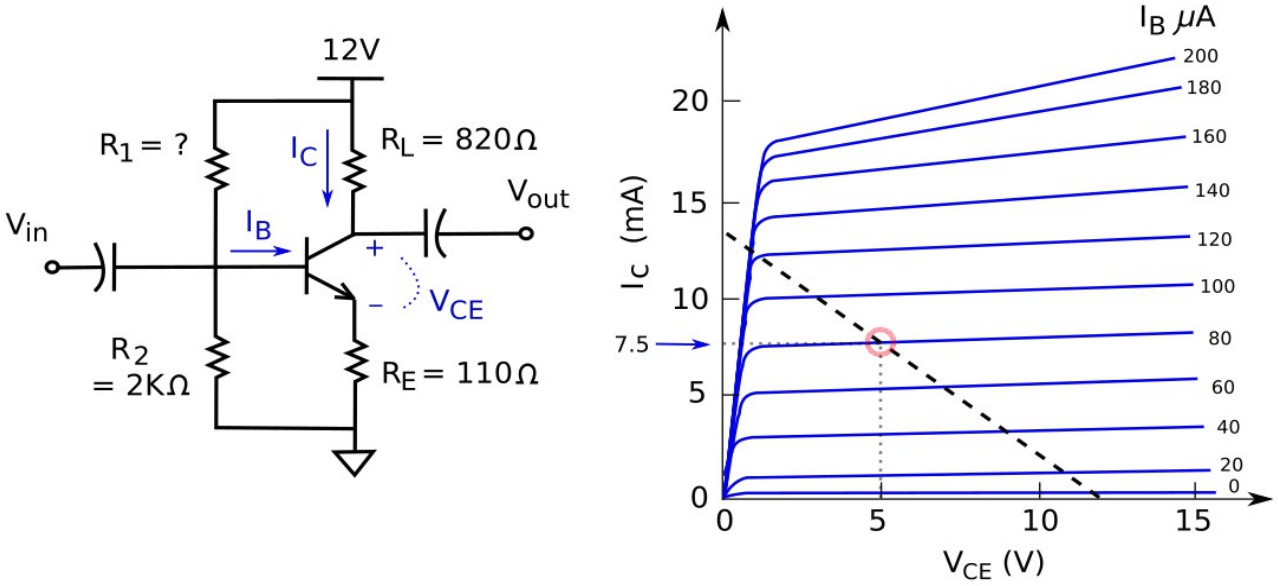
6. ( ) The equivalent circuit on the right shows a faulty condition of a medical instrument. The 110V AC power line is in contact with the metal chassis of an instrument through R_{fault} (200 Ω). The patient resistance (R_P) is 800 Ω. The patient is grounded at GND_P and the instrument is grounded at GND_I. There is a ground loop resistance (R_G) of 0.1 Ω between the two ground points. What is the resulting leakage current (i_P) going through the patient? (A) 550 mA, (B) 74 mA, (C) 110 μA , (D) 69 μA , (E) none of the above.



7. ( ) What is the likely consequence of the above faulty condition based on your calculation of i_P? (A) The leakage current is enough to cause sustained myocardial contractions. (B) The leakage current is enough to cause ventricular fibrillation (V-Fib) for the microshock case. (C) The leakage current is enough to cause V-Fib even for the macroshock case. (D) The patient is likely safe, (E) none of the above.

SEE REVERSE SIDE FOR MORE QUESTIONS

8. ( ) A transistor circuit and the i-v characteristics of the silicon NPN transistor are shown below. The operating point is chosen at the red circle, where I_C = 7.5 mA and I_B = 80 μA. Determine what the bias resistor R_1 should be. Tolerate 20% errors. Choose the value that is sufficiently close. R_1 = ? (A) 470 Ω, (B) 1.2 KΩ, (C) 5.6 KΩ, (D) 14 KΩ, (E) none of the above.



9. ( ) For the above problem, what is the AC voltage gain (V_{out} / V_{in})? (A) -7.45, (B) -9.33, (C) -12.0, (D) -23.5, (E) none of the above.

10. ( ) For 680 nm (wavelength 1) the extinction coefficient is 0.1 for HbO_2 and 0.9 for Hb. For 840 nm (wavelength 2) the extinction coefficient is 0.3 for HbO_2 and 0.2 for Hb. The amplitude-baseline ratio (R) determined at these two wavelengths is 0.5, where R = (A_1 / B_1) / (A_2 / B_2). The arterial blood oxygen saturation (SaO_2) should be (A) 92%, (B) 94%, (C) 96%, (D) 98%, (E) none of the above.