FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

School of Electrical & Electronics Engineering

Trade Diploma in Electronics Engineering

EEE476 – Analog Electronics I

FINAL EXAMINATION

Trimester 3, 2015

Date: As per Exam Time Table

Time: As per Exam Time Table (3 hours)

Venue: As per Exam Timetable

Instructions to Students

1. You are allowed an extra ten (10) minutes of reading time during which you are NOT allowed to write.
2. Attempt ALL questions in this examination booklet
3. Write your answers in the answer booklet provided.
4. Write your Student ID number on each page used.
5. Begin each Section on a fresh page and use both sides of the answer sheet.
6. You may use calculators provided they are non-programmable.
7. Clearly number the questions in your answer paper in their correct sequence and write legibly. Show all working.
8. Attach any extra sheets used to your answer booklet securely with the string provided.

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Section A: Multiple Choices [13 marks]
Choose the letter of the BEST choice.

1. The nucleus of an atom is made up of
(a) protons and neutrons
(b) electrons
(c) electrons and protons
(d) electrons and neutrons

2. The energy band in which free electrons exist is the
(a) first band
(b) second band
(c) conduction band
(d) valence band

3. The process of adding an impurity to an semiconductor is called
(a) doping
(b) recombination
(c) atomic modification
(d) ionization

4. Ideally, a diode can be represented by a
(a) voltage source
(b) resistance
(c) switch
(d) all of these

5. A pn junction is formed by
(a) the recombination of electrons and holes
(b) ionization
(c) the boundary of a p-type and an n-type material
(d) the collision of a proton and a neutron

6. In the complete diode model,
(a) the barrier potential is taken into account
(b) the forward dynamic resistance is taken into account
(c) the reverse resistance is taken into account
(d) all the above

Please Turn Over

7. When a 60 Hz sinusoidal voltage is applied to the input of a half-wave rectifier, the output frequency is
(a) 120 Hz
(b) 30 Hz
(c) 60 Hz
(d) 0 Hz

8. When a 60 Hz sinusoidal voltage is applied to the input of a full-wave rectifier, the output frequency is
(a) 120 Hz
(b) 60 Hz
(c) 240 Hz
(d) 0 Hz

9. When operated in cut-off and saturation, the transistor acts like a
(a) linear amplifier
(b) switch
(c) variable capacitor
(d) variable resistor

10. The cathode of a zener diode in a voltage regulator is normally
(a) more positive than the anode
(b) more negative than the anode
(c) at +0.7 V
(d) grounded

11. The three terminals of a bipolar junction transistor are called
(a) p, n, p
(b) n, p, n
(c) input, output, ground
(d) base, emitter, collector

12. The emitter current is always
(a) greater than the base current
(b) less than the collector current
(c) greater than the collector current
(d) answers (a) and (c)

13. The approximate voltage across the forward-biased base-emitter junction of a silicon BJT is
(a) 0 V
(b) 0.7 V
(c) 0.3 V
(d) VBB

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Section B: [87 marks]

Question 1: Semiconductors/ Diode and application [20 marks]

A) If the atomic number of a neutral atom is 10, how many electrons and protons does the atom have? [1 mark]

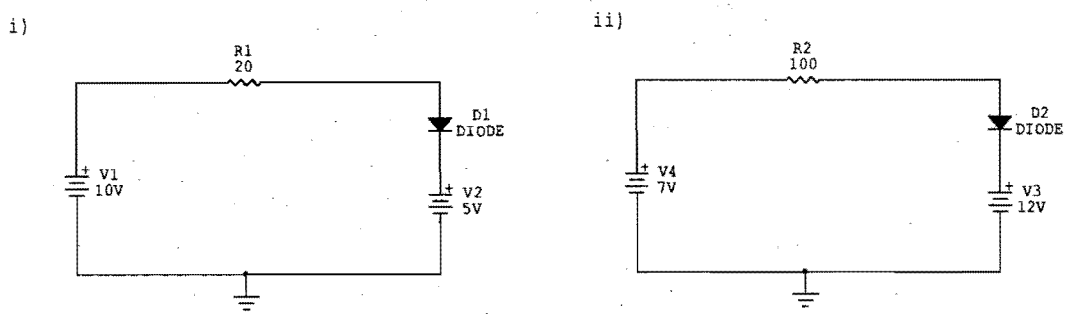
B) What is the basic difference between conductors and insulators? [1 mark]

C) Name three of the best conductive materials. [1 mark]

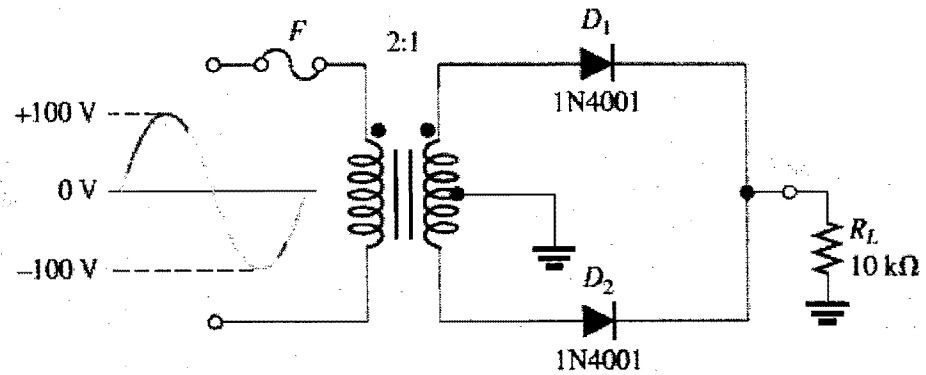
D) Because of its barrier potential, can a diode be used as a voltage source? Explain. [2 marks]

E) What is the difference between a pentavalent atom and a trivalent atom? [1 mark]

F) Determine whether silicon diode in Figure below is forward–biased or reverse-biased, Determine the voltage across diode in Figure below using the complete diode model with r'_d = 15 ohm and r'_R =150M ohm. [5 marks]



G) For the figure given below, show the voltage waveform across each half of the secondary winding and across R_L when a 100 V peak sine wave is applied to the primary winding. Also find the PIV of the diode in the circuit. [6 marks]



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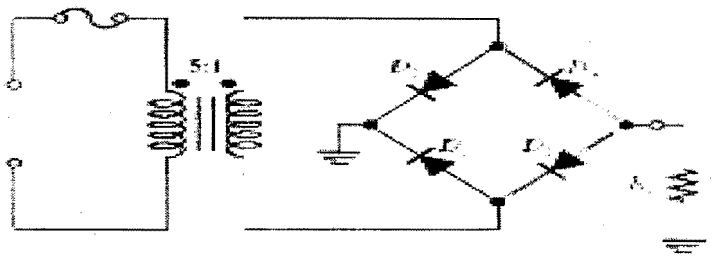
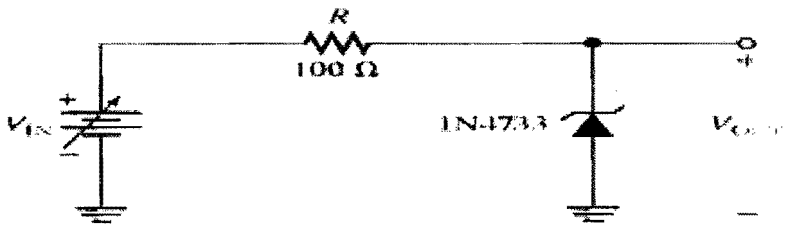
H) Draw the output voltage waveform for the bridge rectifier in the figure below. [3 marks]

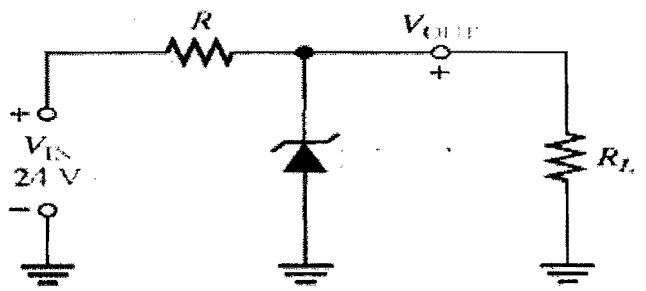


Question 2: Zener diode / voltage regulators [16 marks]

A) Determine the minimum and the maximum input voltages that can be regulated by the zener diode in figure below. From the datasheet for 1N4733A , V_z=5.1V at I_z = 49 mA, I_{zk} =1mA and Z_z =7 ohm at I_z , $PD_{(max)}$ = 1W. [8 marks]



B) For the circuit in the figure below; Determine V_{OUT} at I_{ZK} and I_{ZM}, when R = 130 ohm determine the minimum value of R_L that can be used. From the datasheet zener diode , V_z=15V at I_z = 17 mA, I_{zk} = 0.25mA and Z_z =14 ohm at I_z, PD(max) = 1W. [8 marks]



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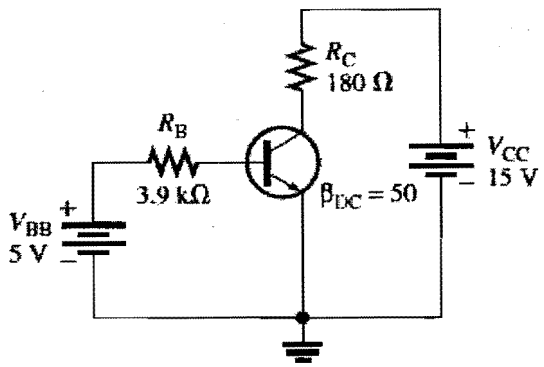
Question 3: SMPS [8 marks]

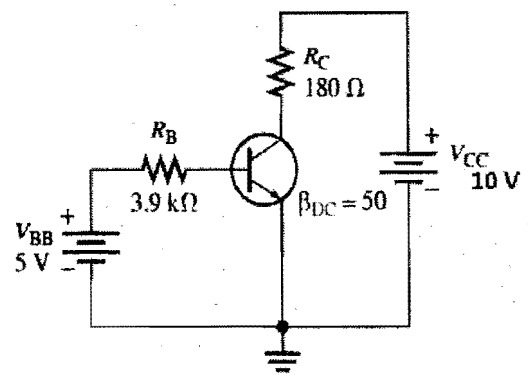
A) Draw the block diagram of the Switch mode power supply (SMPS) and describe each process. [4 marks]
B) Discus the advantages and disadvantages of SMPS compared with linear power supply. [4 marks]

Question 4: BJT [20 marks]

A) Describe the structure of BJT. [2 marks]
B) Find V_{CE}, V_{BE}, and V_{CB} in the circuit below. [5 marks]



C) Determine whether or not the transistor in the figure below is in saturation. Assume $V_{CE(sat)}$ = 0.2 V. [4 marks]



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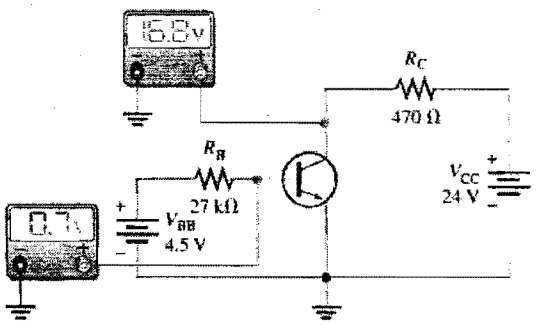
D) What is the value of β_{DC} for the transistor given below? [2 marks]



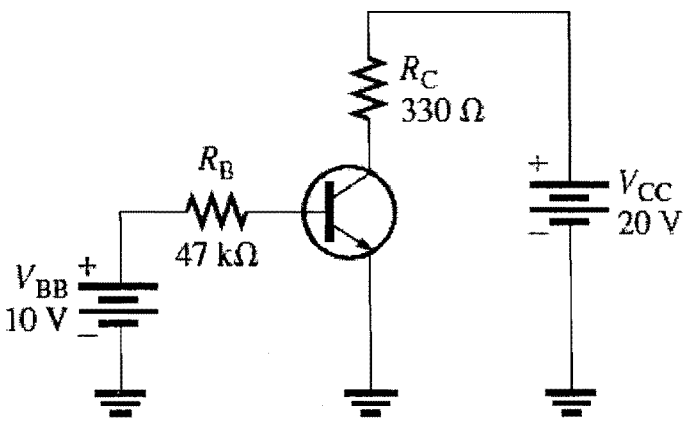
E) In an out-of-circuit test of a good npn transistor, what should an analog ohmmeter indicate when its positive probe is touching the emitter and the negative probe is touching the base? [2 mark]

F) Discuss how a BJT is used as a voltage amplifier. [2.5 marks]

G) Discuss how a BJT is used as a switch. [2.5 marks]

Question 5: Transistor Bias circuit/ BJT amplifier [17 marks]

A) Determine the Q-point for the circuit in figure below and draw the dc load line. Find the maximum peak value of the base current for the linear operation. Assume $\beta_{DC} = 200$. [6 marks]



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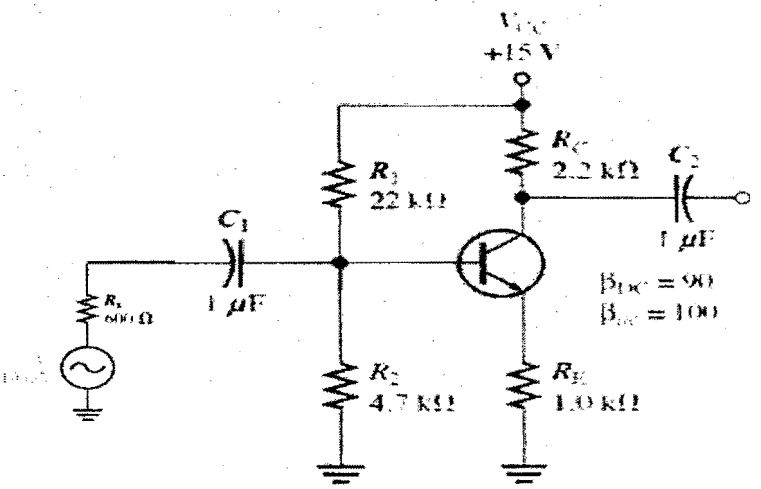
B) i. Draw the dc analysis circuit for the amplifier given below and determine the dc collector voltage. [3 marks]
ii. Draw the ac analysis circuit for the amplifier given below and determine the ac collector voltage. [8 marks]



Question 6: FET [5 marks]

A) Draw the schematic diagrams for a n-channel and p-channel JFET and label the terminals. [2.5 marks]

B) Discuss the JFET and identify how it differs from the BJT. [2.5 marks]

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Formulas

$$r = \frac{V_{r(pp)}}{V_{DC}}$$ Ripple factor

$$V_{r(pp)} \cong \left(\frac{1}{fR_LC}\right)V_{p(rect)}$$ Peak-to-peak ripple voltage, capacitor-input filter

$$V_{DC} = \left(1 - \frac{1}{2fR_LC}\right)V_{p(rect)}$$ DC output voltage, capacitor-input filter

$$I_E = I_C + I_B$$ Transistor currents

$$\beta_{DC} = \frac{I_C}{I_B}$$ DC current gain

$$r'_e \cong \frac{25\text{ mV}}{I_E}$$ Internal ac emitter resistance

Common-Emitter

$$R_{in(base)} = R_1 \| R_2 \| R_{in(base)}$$ Total amplifier input resistance, voltage-divider bias

$$R_{in(base)} = \beta_{ac} r'_e$$ Input resistance at base

$$A_v = \frac{R_C}{r'_e}$$ Voltage gain, base-to-collector, unloaded

$$A_v = \frac{R_C}{r'_e + R_E}$$ Voltage gain without bypass capacitor

$$A_v = \frac{R_c}{r'_e}$$ Voltage gain, base-to-collector, loaded, bypassed R_E

$$\text{Attenuation} = \frac{V_s}{V_b} = \frac{R_s + R_{in(tot)}}{R_{in(tot)}}$$

overall voltage gain of the amplifier, $A'_v = \left(\frac{V_c}{V_b}\right)\left(\frac{V_b}{V_s}\right) = \frac{V_c}{V_s}$