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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JULY 2010 SESSION

SUBJECT CODE	:	FLB 10102
SUBJECT TITLE	:	ELECTRONIC DEVICES
LEVEL	:	BACHELOR
TIME / DURATION	:	9.00 am – 11.00 am (2 HOURS)
DATE	:	21 NOVEMBER 2010

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answers should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer two (2) questions only.
6. Answer all questions in English.
7. Formula is appended.

THERE ARE 11 PAGES OF QUESTIONS, EXCLUDING THIS PAGE AND APPENDIX

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a) Give the three semiconductor elements most commonly used in electronics.

(3 marks)

(b) Give the definition of the doping process.

(3 marks)

(c) Suggest one (1) correct way for each of the following:

i. to forward bias the PN junction

(2 marks)

ii. to reverse bias PN junction

(2 marks)

Question 2

(a) Draw the 3 electrical models of diode in conducting state.

(3 marks)

(b) Draw the conventional I-V curve of a diode in its forward and reverse operating regions. Specify clearly all axis and mark the forward voltage drop and reverse breakdown voltage.

(2 marks)

(c) Refer to the diode circuit in Figure 1. Assume the diode is silicon and uses diode practical model.

i. Determine V_D

(1 marks)

ii. Calculate the diode current, I_D

(2 marks)

(d) Consider the clipper circuit in figure 2. Assume the diode is silicon and use the practical model. Draw v_O , the output voltage and indicate all peaks numerical values. Given V_B = 7.0V and the input, v_I is a pure sinusoidal waveform of amplitude 10.0 Volts.

(2 marks)

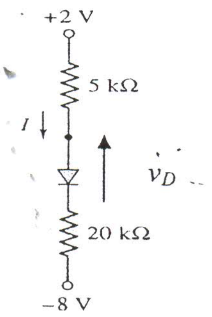


Figure 1

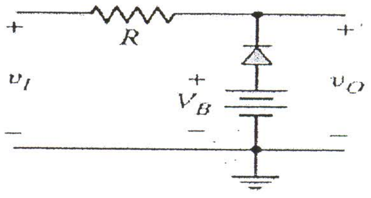


Figure 2

Question 3

A simple voltage regulation circuit is shown in Figure 3. The DC source, V_{PS} = 24.0V.
The data sheet gives the following information:
V_Z = 15V @ I_{ZT} = 17 mA, I_{ZK} = 0.25 mA and Z_{ZT} = 14 ohms, $P_{D(MAX)}$ = 1W.

(a). Determine zener output voltage at maximum permissible zener current.

(2 marks)

(b). Determine zener output voltage at I_{ZK}.

(2 marks)

(c). Calculate the value of R_i for maximum zener current assuming no load resistor.

(2 marks)

(d). Calculate the minimum resistance, R_L (equivalent to maximum load current), that can be used without affecting the zener regulation. Assume R_i = 130 ohms.

(4 marks)

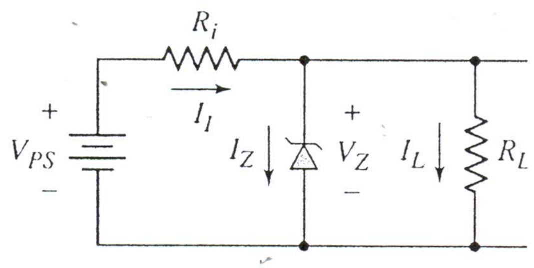


Figure 3

Question 4

A basic full wave rectifier is shown in Figure 4. Assume only silicon diodes are used in the rectifier. Ratio of the transformer is 20:1. Given v_1 = 240Vac 50Hz, R = 330 ohms. Calculate;

(a). the peak secondary voltage, $V_{2(PEAK)}$

(7 marks)

(b). dc load voltage (voltage across R), V_{DC}

(2 marks)

(c). find the DC load current, I_{DC} .

(1 marks)

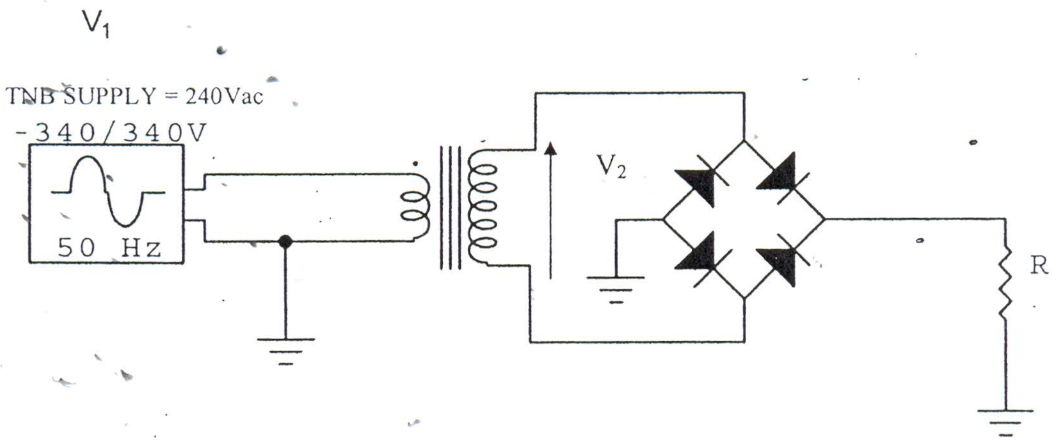


Figure 4

SECTION B (Total: 60 marks)

INSTRUCTION: Answer only TWO (2) questions.

Question 5

Consider the transistor biasing circuit as shown in Figure 5. Assume, R_B = 100Ω, R_C = 750Ω, R_E = 1.5kΩ, V_{CC} = 12.0V, V_{EE} = -12.0V, β = 50.

For the emitter bias circuit in Figure 5, determine the following:

(a). Using Kirchoff Voltage Law (KVL), derive the expression of I_C. Assume $I_E = I_C$.

(5 marks)

(b). With the same method, derive the expression of V_{CE}.

(5 marks)

(c). Find the numerical value of I_C and V_{CE}.

(4 marks)

(d). Determine $I_{C(SAT)}$ and $V_{CE(OFF)}$.

(4 marks)

(e). Comment whether the transistor is midpoint biased.

(2 marks)

(f). The transistor is changed to a type with β=100. Find the new numerical values of I_C and V_{CE}. Comment whether it is midpoint biased.

(4 marks)

(g). Calculate the percentage of change of I_C and V_{CE}. Use the formulas

$$\Delta I_C(\%) = \frac{|I_{C1} - I_{C2}|}{I_{C1}} \times 100 \quad \text{and} \quad \Delta V_{CE}(\%) = \frac{|V_{CE1} - V_{CE2}|}{V_{CE1}} \times 100 .$$

I_{C1} and V_{CE1} values are for β =100 and I_{C2} and V_{CE2} for β =200.

(4 marks)

(h). Give your observation on the performance of the emitter bias from the percentage of change of I_C and V_{CE} due to β.

(2 marks)

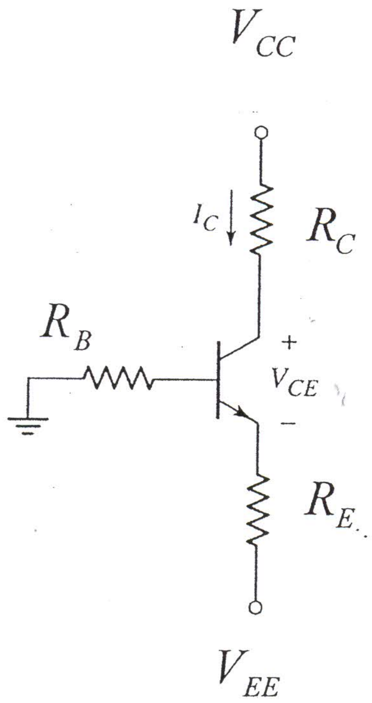


Figure 5

Question 6

A small electronic board is being repaired by a student during his internship in a company. Through a reverse engineering process, the student was able to redraw the power supply portion which is shown in Figure 6. All the bridge rectifier diodes were blown or damaged, thus its part numbers could not be retrieved. However, other parts shown in figure 6 are still in good condition and their values are shown in figure 6. The student is required to replace the diodes with suitable types. In the process, he has to recalculate the electrical performance of the circuit.

Assume:

- D1-D4 the rectifier diodes to be replaced
- the transformer ratio is 2.67 : 1.
- D_Z is the zener diode with Vz = 39.8V, Zz= 13 ohms, Izm = 100mA.
- $R_S = 66\Omega$, $R_L = 470\Omega$

(a) Calculate $V_{2(pk)}$.

(3 marks)

(b) Calculate peak value at rectifier output $V_{C(pk)}$

(2 marks)

(c) Determine I_S , the total current through R_S .(assume $V_{C(pk)}$ as peak voltage).

(2 marks)

(d) Determine the value of ripple voltage through the filter, V_R .

(3 marks)

(e) Obtain the AC equivalent circuit of the circuit portion containing R_S , zener and R_L .

This portion of circuit is subjected to the input ripple, V_R and the output ripple is $V_{R(OUT)}$. By using the AC analysis, solve $V_{R(OUT)}$. (Hint : zener has its AC equivalent model).

(6 marks)

(f) Determine which part number of diode is suitable to replace the damaged diode. The student is required to name the CHEAPEST part from all parts deemed suitable, knowing that with increased rating, the cost will be more expensive. Select and name 1 (one) diode from datasheets in figures 7 & 8. Justify your choice by 2 specifications or parameter.

(6 marks)

(g) Find load current, I_L.

(2 marks)

(h) The student desires to reduce the ripple ($V_{R(OUT)}$) to be made smaller than 2.0Vpp to be able to use the power supply for a certain application. However he only has capacitors of 2200uF. Calculate how much capacitors needed to be added to obtain the above specification.

(6 marks)

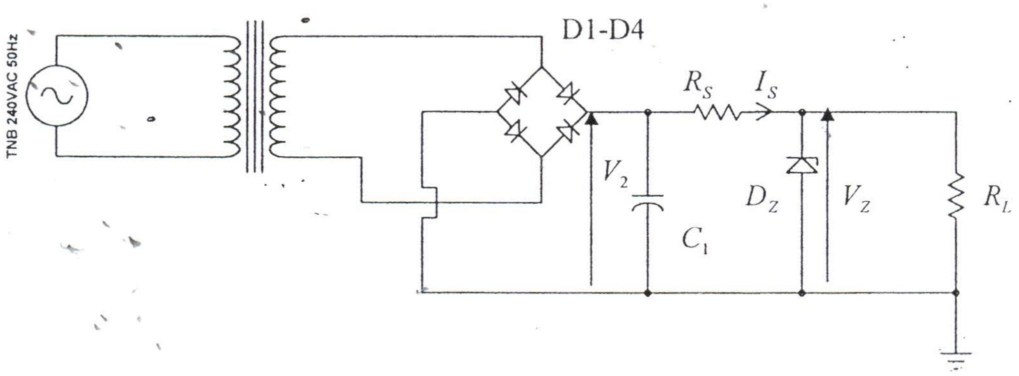


Figure 6

FAIRCHILD SEMICONDUCTOR®

1N4001-1N4007

1N4001 - 1N4007

Features

- Low forward voltage drop.
- High surge current capability.

DO-41
COLOR BAND DENOTES CATHODE

General Purpose Rectifiers (Glass Passivated)

Absolute Maximum Ratings* T_A = 25°C unless otherwise noted

Symbol	Parameter	Value							Units
		4001	4002	4003	4004	4005	4006	4007	
V_{RRM}	Peak Repetitive Reverse Voltage	50	100	200	400	600	800	1000	V
$I_{F(AV)}$	Average Rectified Forward Current, .375 " lead length @ T_A = 75°C	1.0							A
I_{FSM}	Non-repetitive Peak Forward Surge Current 8.3 ms Single Half-Sine-Wave	30							A
T_{stg}	Storage Temperature Range	-55 to +175							°C
T_J	Operating Junction Temperature	-55 to +175							°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

Thermal Characteristics

Symbol	Parameter	Value	Units
P_D	Power Dissipation	3.0	W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W

Electrical Characteristics T_A = 25°C unless otherwise noted

Symbol	Parameter	Device							Units
		4001	4002	4003	4004	4005	4006	4007	
V_F	Forward Voltage @ 1.0 A	1.1							V
I_{rr}	Maximum Full Load Reverse Current, Full Cycle T_A = 75°C	30							µA
I_R	Reverse Current @ rated V_R T_A = 25°C T_A = 100°C	5.0 500							µA µA
C_T	Total Capacitance V_R = 4.0 V, f = 1.0 MHz	15							pF

 1N4001-1N4007, Rev. C

Figure 7

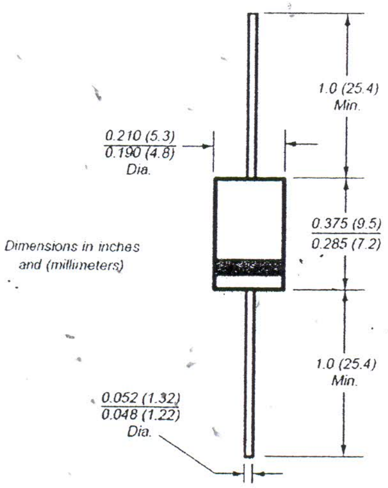
1N5400 thru 1N5408

Vishay Semiconductors
formerly General Semiconductor

General Purpose Plastic Rectifiers

Reverse Voltage 50 to 1000V
Forward Current 3.0A

DO-201AD



Features

- Plastic package has Underwriters Laboratories Flammability Classification 94V-0
- High surge current capability
- Construction utilizes void-free molded plastic technique
- 3.0 Ampere operation at T_L=105°C with no thermal runaway
- Typical I_R less than 0.1μA
- High temperature soldering guaranteed: 250°C/10 seconds, 0.375" (9.5mm) lead length, 5 lbs. (2.3kg) tension

Mechanical Data

Case: JEDEC DO-201AD, molded plastic body
Terminals: Plated axial leads, solderable per MIL-STD-750, Method 2026
Polarity: Color band denotes cathode end
Mounting Position: Any
Weight: 0.04 oz., 1.1 g

Maximum Ratings & Thermal Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

Parameter	Symb.	1N 5400	1N 5401	1N 5402	1N 5403	1N 5404	1N 5405	1N 5406	1N 5407	1N 5408	Unit
* Maximum repetitive peak reverse voltage	V_{RRM}	50	100	200	300	400	500	600	800	1000	V
* Maximum RMS voltage	V_{RMS}	35	70	140	210	280	350	420	560	700	V
* Maximum DC blocking voltage to T_A = 150°C	V_{DC}	50	100	200	300	400	500	600	800	1000	V
* Maximum average forward rectified current 0.5" (12.5mm) lead length at T_L = 105°C	$I_{F(AV)}$	3.0									A
* Peak forward surge current 8.3ms single half sine-wave superimposed on rated load (JEDEC Method) at T_L=105°C	I_{FSM}	200									A
* Maximum full load reverse current, full cycle average 0.5" (12.5mm) lead length at T_L = 105°C	$I_{R(AV)}$	500									μA
* Typical thermal resistance[1]	$R_{\theta JA}$	20									°C/W
Maximum DC blocking voltage temperature	T_A	+150									°C
* Operating junction and storage temperature range	T_J, T_{STG}	−50 to +170									°C

Electrical Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

Parameter	Symb.	Value	Unit
* Maximum instantaneous forward voltage at 3.0A	V_F	1.2	V
* Maximum DC reverse current at rated DC blocking voltage — T_A = 25°C / T_A = 150°C	I_R	5 / 500	μA
Typical junction capacitance at 4.0V, 1MHz	C_J	30	pF

Note: (1) Thermal resistance from junction to ambient at 0.375" (9.5mm) lead length, P.C.B. mounted with 0.8 x 0.8" (20 x 20mm) copper heatsinks
*JEDEC registered values

Figure 8

Question 7

A common emitter amplifier has been designed to amplify audio signal being emitted from a microphone as shown in Figure 9. A certain voltage gain is needed to be fed into adjacent circuit which loading is estimated as a resistor R5 of 40kΩ. Assume the ac emitter resistance is $r'_e = \frac{25mV}{I_E}$.

Calculate:

(a). Base voltage, V_B (assume stiff voltage divider for R1 and R2).

(5 marks)

(b). Emitter voltage, V_E

(5 marks)

(c). Emitter current, I_E

(5 marks)

(d). AC emitter resistance, r'_e

(5 marks)

(e). AC resistance of collector circuit, r_C.

(5 marks)

(f). V_{OUT}, the voltage amplitude across load resistor R5 if the input of amplifier (the microphone output) is constant at 15mV. (Hint: calculate first the gain of the amplifier, A_V).

(5 marks)

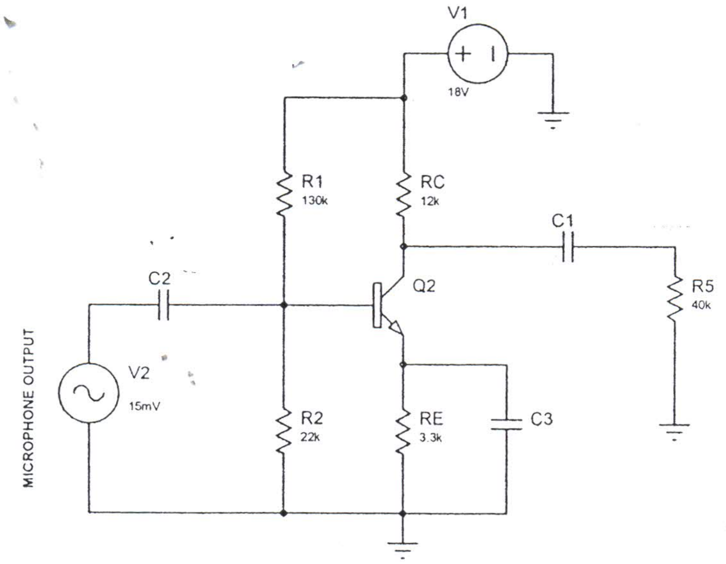


Figure 9

END OF QUESTION PAPER

APPENDIX

FORMULA

HALF WAVE

$$V_{L(PK)} = V_{2(PK)} - V_F$$
$$V_{(AVE)} = 0.318 \times V_{L(PK)}$$
$$PIV = V_{2(PK)}$$

FULL WAVE CENTER TAPPED TRANSFORMER

$$V_{L(PK)} = \frac{V_{2(PK)}}{2} - V_F$$
$$V_{(AVE)} = 0.636 \times V_{L(PK)}$$
$$PIV = V_{2(PK)} - V_F$$

FULL WAVE BRIDGE

$$V_{L(PK)} = V_{2(PK)} - 2 \times V_F$$
$$V_{(AVE)} = 0.636 \times V_{L(PK)}$$
$$PIV = V_{2(PK)} - V_F$$

ZENER DIODES

$$V_{ZK} = V_{ZT} - Z_Z \cdot (I_{ZT} - I_{ZK})$$
$$V_{ZM} = V_{ZT} + Z_Z \cdot (I_{ZM} - I_{ZT})$$
$$I_{ZM} = \frac{P_{D(MAX)}}{V_{ZT}}$$