Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	ELECTRONIC PRINCIPLES
COURSE CODE	:	BNR 20503
PROGRAMME	:	BND/BNF
EXAMINATION DATE	:	JUNE 2017
DURATION	:	2 HOURS AND 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Define semiconductor.
(2 marks)

(b) Differentiate between instrinsic and extrinsic semiconductors.
(4 marks)

(c) Differentiate between N-type and P-type extrinsic semiconductors.
(4 marks)

(d) Explain in detail the operation of diode when it is reverse bias.
(5 marks)

(e) Calculate the load voltage, load current and diode power in **Figure Q1(e)** using the second approximation.
(10 marks)

Q2 (a) Illustrate and explain the operation of bridge rectifier circuit.
(7 marks)

(b) Draw the current-voltage (IV) characteristic of a zener diode.
(3 marks)

(c) Based on the IV characteristic drawn in **Question Q2(b)**, explain what happen if the reversed voltage applied to the zener diode start to increase until breakdown voltage.
(5 marks)

(d) From datasheet of MMBT3904 NPN shown in **Appendix A** and **Appendix B** general purpose amplifier, determine:

(i) Maximum current and power.
(ii) Current gain.
(iii) A MMBT3904 has V_{CE} = 10 V and I_C = 20 mA. Analyze the power dissipation. Assess the safety level of power dissipation if the ambient temperature is 50°C.
(10 marks)

Q3 (a) A transistor has a current gain of 120 and a base current of 35 mA. Calculate the collector current.
(2 marks)

(b) A transistor with equal base and collector supplies is shown in **Figure Q3(b)**. Analyze the collector-emitter voltage in this circuit and the transistor power.
(7 marks)

(c) Determine the collector current at the saturation point and draw the load line for **Figure Q3(c)**. Analyze the collector-emitter voltage at the cutoff point. What is the voltage between the collector and ground if the current gain is 250?
(8 marks)

(d) Determine the Q point for circuit in **Figure Q3(d)**. The power supply has a tolerance of ±10 percent. Analyze the lowest and highest possible value of Q point.

(8 marks)

Q4 (a) A 2N5555 has I_{DSS} = 18 mA and $V_{GS(off)}$ = -5 V. Calculate the pinchoff voltage for this JFET and the drain-source resistance R_{DS}.

(3 marks)

(b) Calculate the drain saturation current and drain voltage in **Figure Q4(b)**. If the 12 kΩ resistor is increased to 20 kΩ, analyze the drain voltage.

(7 marks)

(c) Calculate the ideal drain voltage of the circuit shown in **Figure Q4(c)**. Analyze the Q point by drawing the DC load line of the circuit.

(10 marks)

(d) A 2N4416 has I_{DSS} = 13 mA and g_{m0} = 2000 μS. Determine the gate-source cutoff voltage and the value of g_m for V_{GS} = -5 V. If V_{GS} = -2 V, determine which JFET amplifier that has better control of the gate voltage over the drain current.

(5 marks)

- END OF QUESTIONS -

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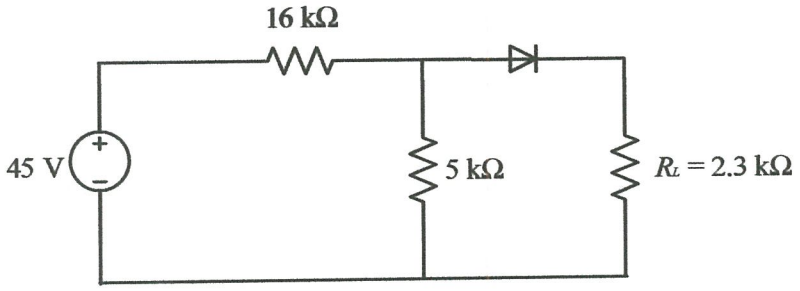

Figure Q1(e)

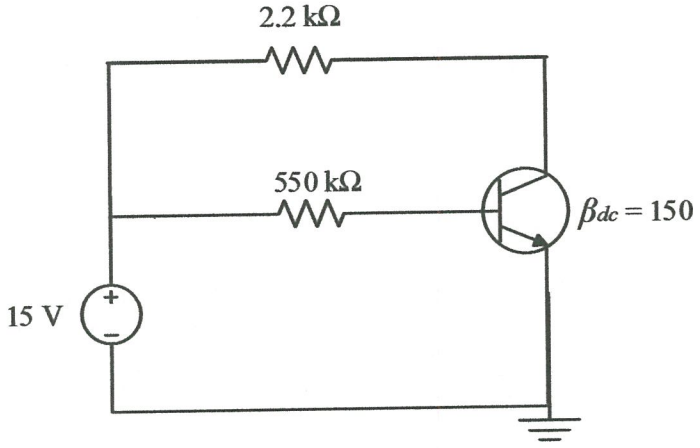

Figure Q3(b)

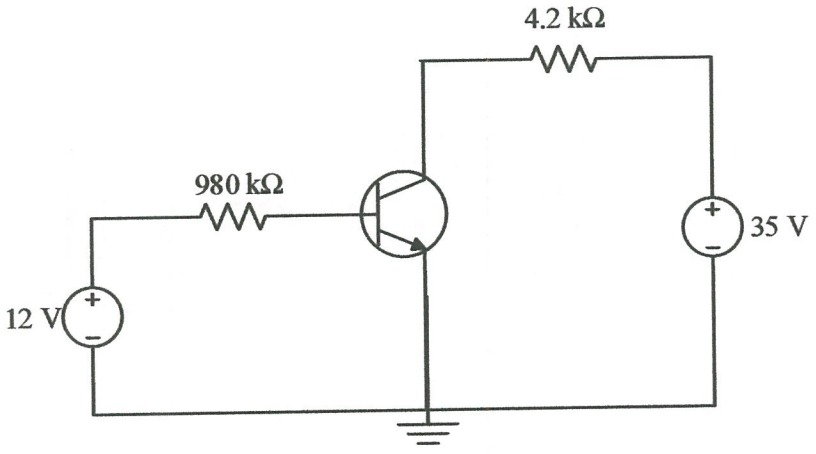

Figure Q3(c)

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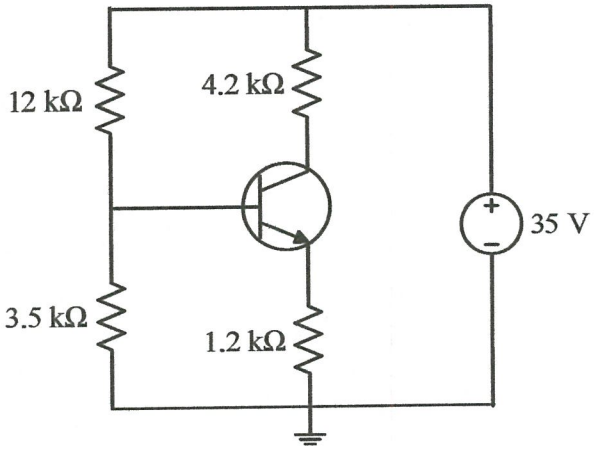

Figure Q3(d)

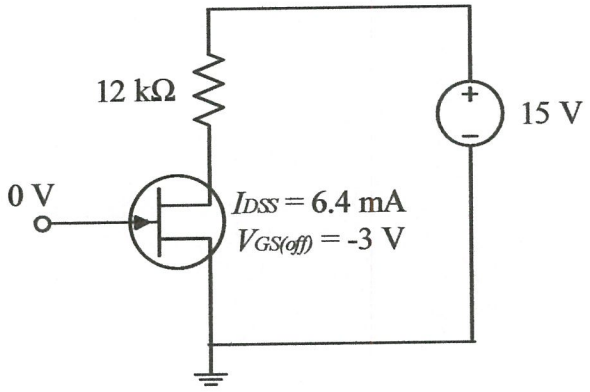

Figure Q4(b)

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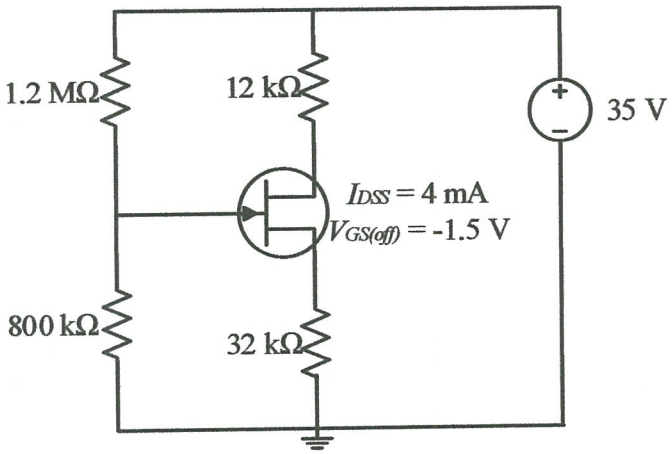

Figure Q4(c)

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APPENDIX A

Figure 6-15(a) 2 tor. Used by permission.)

FAIRCHILD SEMICONDUCTOR®

October 2011

2N3904 / MMBT3904 / PZT3904
NPN General Purpose Amplifier

Features

- This device is designed as a general purpose amplifier and switch.
- The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier.

2N3904 MMBT3904 PZT3904

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

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

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

NOTES:

1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Thermal Characteristics T_a = 25°C unless otherwise noted

Symbol	Parameter	Max.			Units
		2N3904	*MMBT3904	**PZT3904	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

* Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06".
** Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

2N3904 / MMBT3904 / PZT3904 Rev. B0

www.fairchildsemi.com

2N3904 / MMBT3904 / PZT3904 — NPN General Purpose Amplifier

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Chapter 6

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APPENDIX B

Figure 6-15(*b*) (continued)

Electrical Characteristics T_a = 25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Max.	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 1.0mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10μA, I_E = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10μA, I_C = 0	6.0		V
I_{BL}	Base Cutoff Current	V_{CE} = 30V, V_{EB} = 3V		50	nA
I_{CEX}	Collector Cutoff Current	V_{CE} = 30V, V_{EB} = 3V		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 0.1mA, V_{CE} = 1.0V I_C = 1.0mA, V_{CE} = 1.0V I_C = 10mA, V_{CE} = 1.0V I_C = 50mA, V_{CE} = 1.0V I_C = 100mA, V_{CE} = 1.0V	40 70 100 60 30	300	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10mA, I_B = 1.0mA I_C = 50mA, I_B = 5.0mA		0.2 0.3	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10mA, I_B = 1.0mA I_C = 50mA, I_B = 5.0mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10mA, V_{CE} = 20V, f = 100MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 5.0V, I_E = 0, f = 1.0MHz		4.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5V, I_C = 0, f = 1.0MHz		8.0	pF
NF	Noise Figure	I_C = 100μA, V_{CE} = 5.0V, R_S = 1.0kΩ, f = 10Hz to 15.7kHz		5.0	dB
SWITCHING CHARACTERISTICS					
t_d	Delay Time	V_{CC} = 3.0V, V_{BE} = 0.5V I_C = 10mA, I_{B1} = 1.0mA		35	ns
t_r	Rise Time			35	ns
t_s	Storage Time	V_{CC} = 3.0V, I_C = 10mA, I_{B1} = I_{B2} = 1.0mA		200	ns
t_f	Fall Time			50	ns

* Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2.0%

Ordering Information

Part Number	Marking	Package	Packing Method	Pack Qty
2N3904BU	2N3904	TO-92	BULK	10000
2N3904TA	2N3904	TO-92	AMMO	2000
2N3904TAR	2N3904	TO-92	AMMO	2000
2N3904TF	2N3904	TO-92	TAPE REEL	2000
2N3904TFR	2N3904	TO-92	TAPE REEL	2000
MMBT3904	1A	SOT-23	TAPE REEL	3000
MMBT3904_D87Z	1A	SOT-23	TAPE REEL	10000
PZT3904	3904	SOT-223	TAPE REEL	2500