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UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
SEPTEMBER 2016 SEMESTER

COURSE CODE	:	LEB10603
COURSE NAME	:	ANALOGUE ELECTRONICS
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	BACHELOR OF ENGINEERING TECHNOLOGY IN MARINE ELECTRICAL AND ELECTRONICS
DATE	:	17TH JANUARY 2017
TIME	:	02.00 PM – 05.00 PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please CAREFULLY read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of TWO (2) sections; Section A and Section B.
4. Answer ALL questions in Section A. For Section B, answer TWO (2) questions.
5. Please write your answers on the answer booklet provided.
6. Answer all questions in English language ONLY.

THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION B (Total: 40 marks)

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

Question 1

(a) Explain why a centered Q-point is important for a class A power amplifier.
(Course Learning Outcome: 1)

(11 marks)

(b) Explain class B power amplifiers operation.
(Course Learning Outcome: 1)

(5 marks)

(c) Identify at what point a class C power amplifier is normally biased.
(Course Learning Outcome: 1)

(2 marks)

(d) Explain briefly the purpose of the tuned circuit in a class C power amplifier.
(Course Learning Outcome: 1)

(2 marks)

Question 2

(a) List the amplifier stages in typical operational amplifier.
(Course Learning Outcome: 1)

(3 marks)

(b) Describe the general effects of negative feedback on operational amplifier performance.
(Course Learning Outcome: 1)

(8 marks)

(c) Describe the operation of zero-level detector as one of op-amp application.
(Course Learning Outcome: 1)

(7 marks)

(d) Describe briefly the purpose of **hysteresis** in a comparator.
(Course Learning Outcome: 1)

(2 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer THREE (3) questions ONLY.
Please use the answer booklet provided.

Question 3

(a) Analyse the circuit shown in Figure 1 and answer the following questions:

i. Determine the V_{CE} when $V_{IN} = 0V$.

(4 marks)

ii. Determine the minimum value of I_B is required to saturate this transistor if β_{DC} is 250. Neglect $V_{CE(sat)}$.

(4 marks)

iii. Calculate the maximum value of R_B when $V_{IN} = 8V$.

(5 marks)

(*Course Learning Outcome 2)*

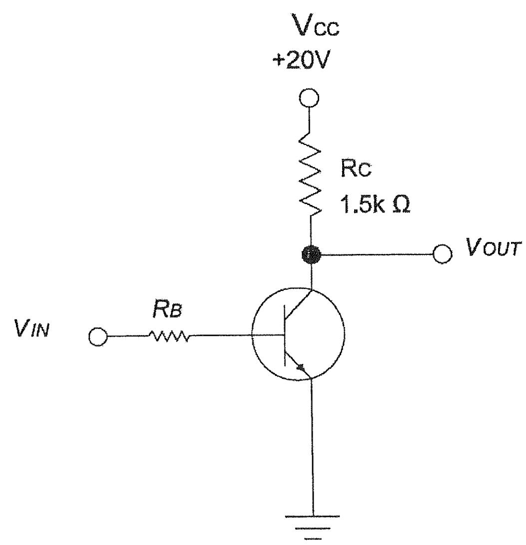

Figure 1

(b) Determine the value of I_E and V_{CE} for the circuit in Figure 2 using the approximations $V_E \cong -2V$ and $I_C \cong I_E$.

(*Course Learning Outcome 2)* *(7 marks)*

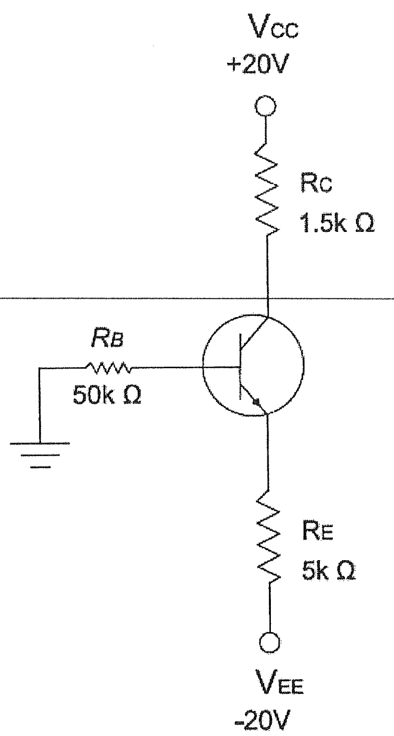

Figure 2

Question 4

(a) Determine V_{BB}, V_E, I_B, I_C, and V_{CE} for a base-biased transistor circuit with the following values:

$\beta_{DC} = 100$, $V_{CC} = 15V$, $R_B = 20k\Omega$, and $R_C = 100\Omega$.

(*Course Learning Outcome 2)* *(8 marks)*

(b) Design a collector-feedback circuit using a 2N2222A (refer APPENDIX 1) with $V_{CC} = 10V$, $I_C = 10mA$, and $V_{CE} = 3V$.

(*Course Learning Outcome 2)* *(12 marks)*

Question 5

Design a circuit using an n-channel E-MOSFET with the following datasheet specifications: $I_{D(on)} = 500mA @ V_{GS} = 10V$ and $V_{GS(th)} = 1V$. Use a +15V dc supply voltage with voltage divider bias. The voltage at the drain with respect to ground is to be +10V. The maximum current from the supply is to $25mA$.

(Course Learning Outcome 2)

(20 marks)

Question 6

Analyse the circuit shown in Figure 3, answer the following question:

(a) Draw the dc equivalent circuit.

(2 marks)

(b) Determine the dc collector voltage.

(6 marks)

(c) Draw the ac equivalent circuit.

(2 marks)

(d) Determine the ac collector voltage.

(10 marks)

(Course Learning Outcome 2)

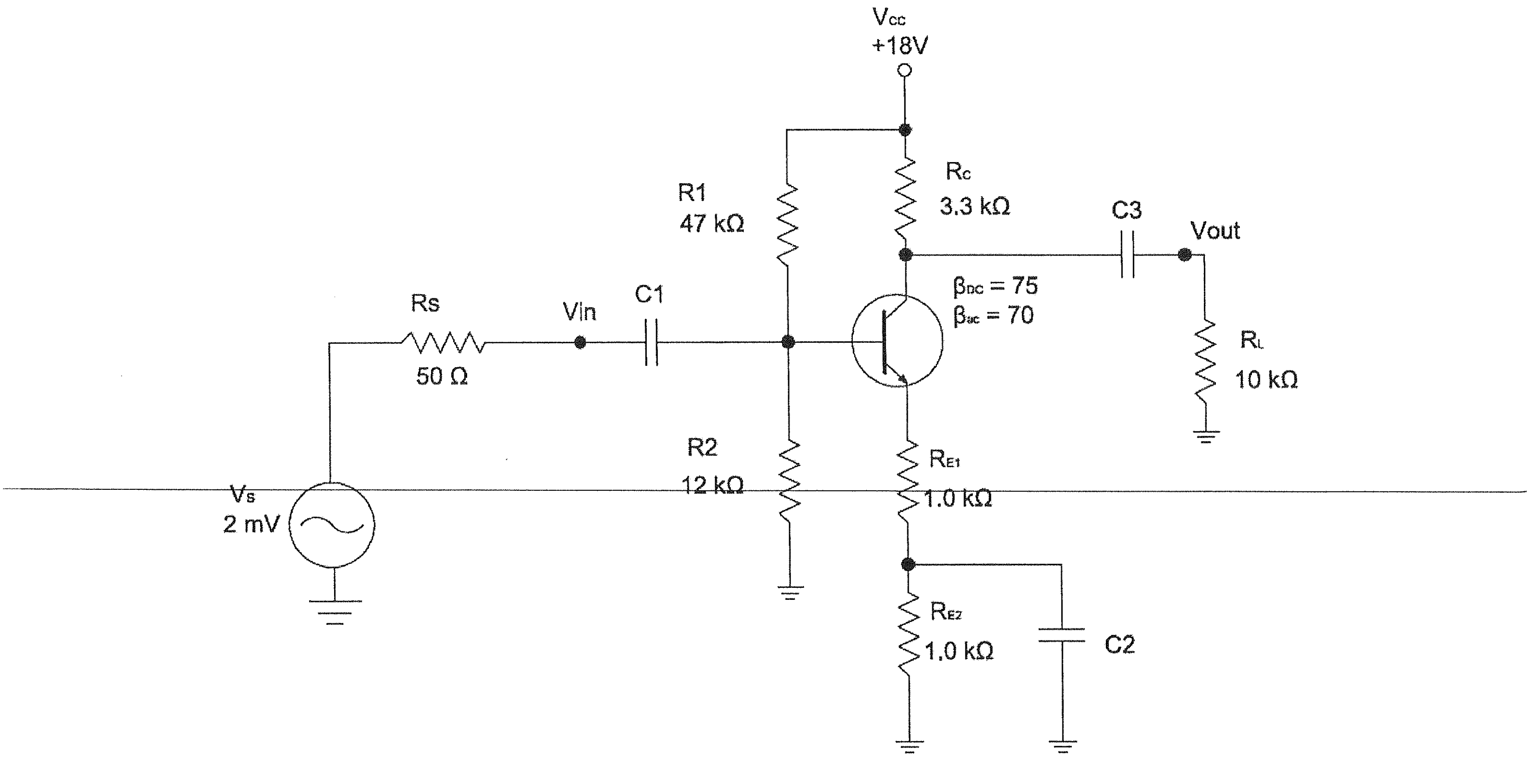

Figure 3

END OF EXAMINATION PAPER

APPENDIX 1

FAIRCHILD
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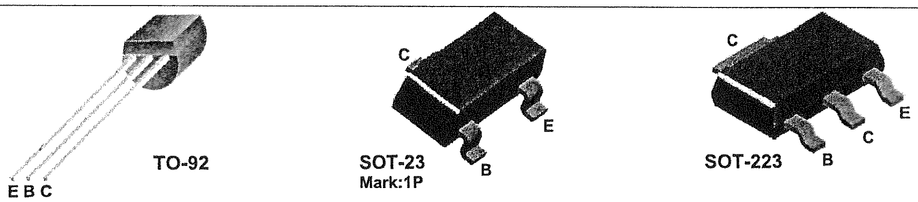
August 2010

PN2222A / MMBT2222A / PZT2222A
NPN General Purpose Amplifier

Features

- This device is for use as a medium power amplifier and switch requiring collector currents up to 500mA.
- Sourced from process 19.

PN2222A **MMBT2222A** **PZT2222A**



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	75	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current	1.0	A
T_{STG}	Operating and Storage Junction Temperature Range	- 55 ~ 150	°C

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

NOTES:

1) These rating are based on a maximum junction temperature of 150 degrees C.
2) These are steady 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
		PN2222A	*MMBT2222A	**PZT2222A	
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" × 1.6" × 0.06".

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

Electrical Characteristics T_a = 25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Max.	Units
Off Characteristics					
$BV_{(BR)CEO}$	Collector-Emitter Breakdown Voltage *	I_C = 10mA, I_B = 0	40		V
$BV_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10μA, I_E = 0	75		V
$BV_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10μA, I_C = 0	6.0		V
I_{CEX}	Collector Cutoff Current	V_{CE} = 60V, $V_{EB(off)}$ = 3.0V		10	nA
I_{CBO}	Collector Cutoff Current	V_{CB} = 60V, I_E = 0 V_{CB} = 60V, I_E = 0, T_a = 125°C		0.01 10	μA μA
I_{EBO}	Emitter Cutoff Current	V_{EB} = 3.0V, I_C = 0		10	nA
I_{BL}	Base Cutoff Current	V_{CE} = 60V, $V_{EB(off)}$ = 3.0V		20	nA
On Characteristics					
h_{FE}	DC Current Gain	I_C = 0.1mA, V_{CE} = 10V I_C = 1.0mA, V_{CE} = 10V I_C = 10mA, V_{CE} = 10V I_C = 10mA, V_{CE} = 10V, T_a = -55°C I_C = 150mA, V_{CE} = 10V * I_C = 150mA, V_{CE} = 1V * I_C = 500mA, V_{CE} = 10V *	35 50 75 35 100 50 40	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage *	I_C = 150mA, I_B = 15mA I_C = 500mA, I_B = 50mA		0.3 1.0	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage *	I_C = 150mA, I_B = 15mA I_C = 500mA, I_B = 50mA	0.6	1.2 2.0	V V
Small Signal Characteristics					
f_T	Current Gain Bandwidth Product	I_C = 20mA, V_{CE} = 20V, f = 100MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 10V, I_E = 0, f = 1MHz		8.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5V, I_C = 0, f = 1MHz		25	pF
$rb'C_c$	Collector Base Time Constant	I_C = 20mA, V_{CB} = 20V, f = 31.8MHz		150	pS
NF	Noise Figure	I_C = 100μA, V_{CE} = 10V, R_S = 1.0KΩ, f = 1.0KHz		4.0	dB
$Re(h_{ie})$	Real Part of Common-Emitter High Frequency Input Impedance	I_C = 20mA, V_{CE} = 20V, f = 300MHz		60	Ω
Switching Characteristics					
t_d	Delay Time	V_{CC} = 30V, $V_{EB(off)}$ = 0.5V, I_C = 150mA, I_{B1} = 15mA		10	ns
t_r	Rise Time			25	ns
t_s	Storage Time	V_{CC} = 30V, I_C = 150mA, I_{B1} = I_{B2} = 15mA		225	ns
t_f	Fall Time			60	ns

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

Typical Performance Characteristics

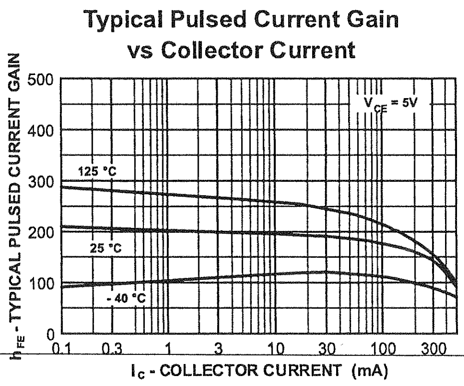


Figure 1. Typical Pulsed Current Gain vs Collector Current

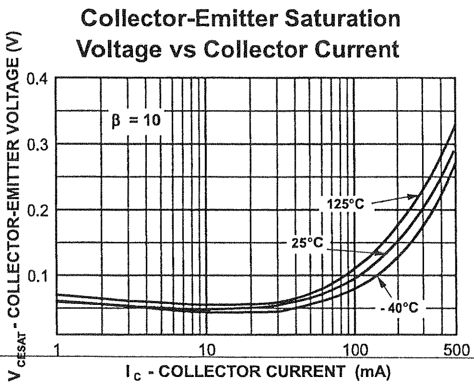


Figure 2. Collector-Emitter Saturation Voltage vs Collector Current

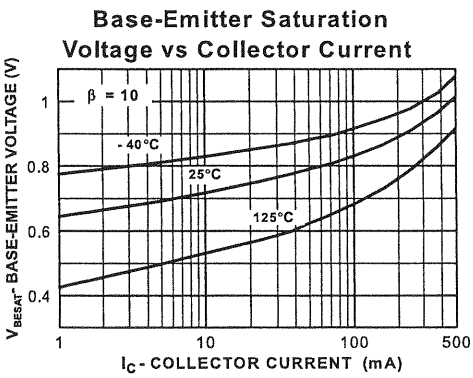


Figure 3. Base-Emitter Saturation Voltage vs Collector Current

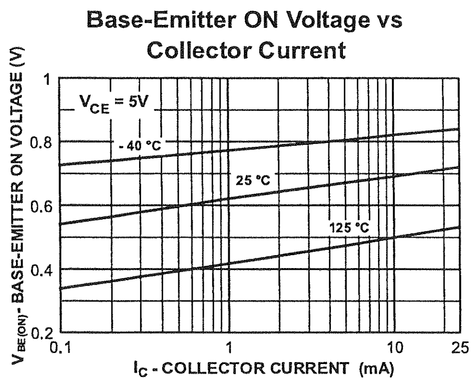


Figure 4. Base-Emitter On Voltage vs Collector Current

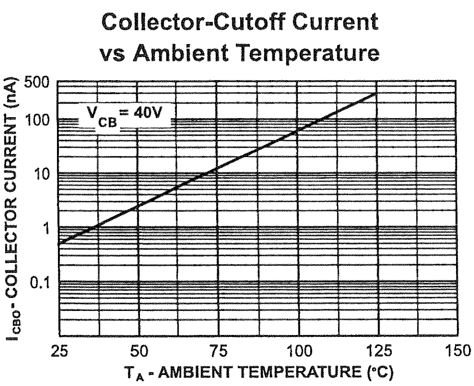


Figure 5. Collector Cutoff Current vs Ambient Temperature

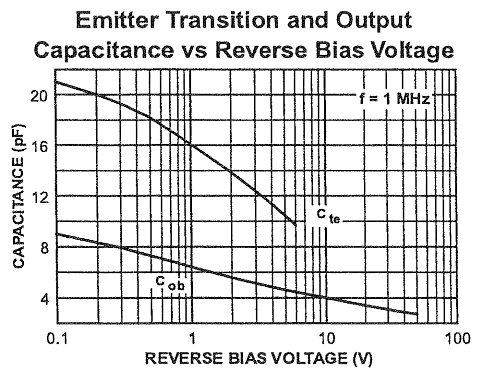


Figure 6. Emitter Transition and Output Capacitance vs Reverse Bias Voltage

Typical Performance Characteristics (Continued)

Turn On and Turn Off Times vs Collector Current

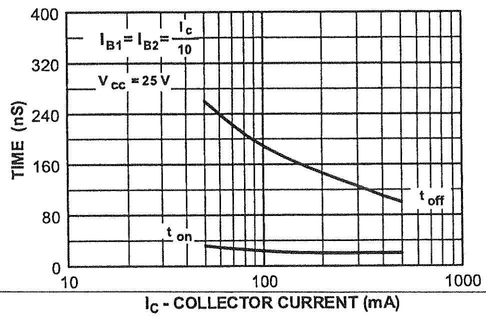


Figure 7. Turn On and Turn Off Times vs Collector Current

Switching Times vs Collector Current

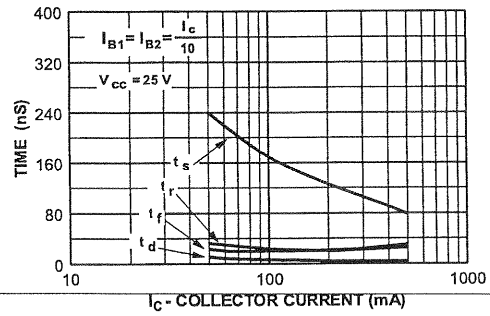


Figure 8. Switching Times vs Collector Current

Power Dissipation vs Ambient Temperature

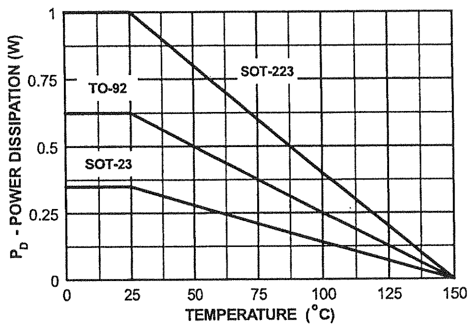


Figure 9. Power Dissipation vs Ambient Temperature

Common Emitter Characteristics

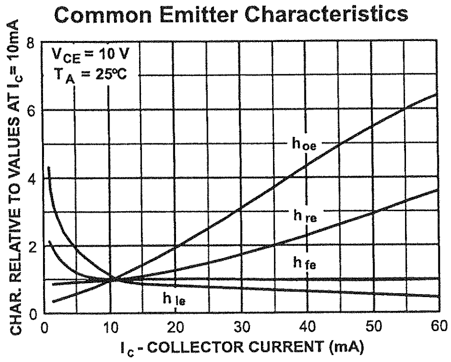


Figure 10. Common Emitter Characteristics

Common Emitter Characteristics

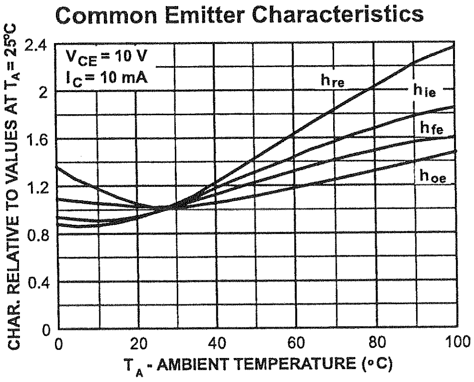


Figure 11. Common Emitter Characteristics

Common Emitter Characteristics

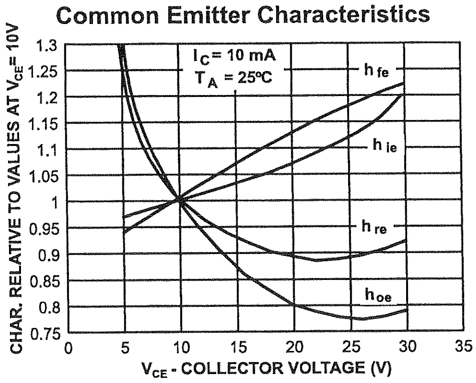


Figure 12. Common Emitter Characteristics

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No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
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