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GALWAY

SEMESTER 1 (WINTER) EXAMINATIONS 2000-01

3rd year B.Sc.Unit EP312: Electronics and Devices

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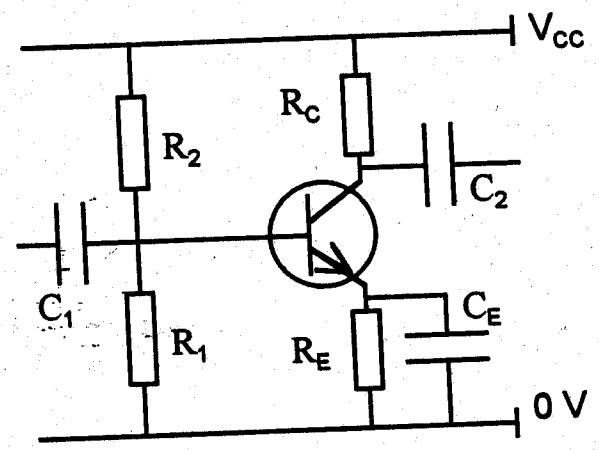
Time allowed TWO hours	Answer THREE questions

Q.1 The diagram shows a standard Common Emitter (CE) amplifier stage where the known component values are: $V_{CC} = 10$ V, $R_C = 4$ kΩ, $R_E = 1$ kΩ, and $C_E = 47$ μF. The transistor has a current gain $\beta = 300$ (nominal) and $f_T = 500$ MHz (nominal).



Demonstrate that suitable values for R1 and R2 to set the amplifier Q point at (1mA, 5 V) are 15 and 85 kΩ, respectively. Calculate the circuit stability factor, S. State briefly why S is important, and say how its numerical value can be reduced. What are the drawbacks of reducing S in these ways?

Calculate the approximate mid-band amplifier input impedance and the small signal voltage gain. What are the purposes of C_1 and C_2? Estimate approximately the low and high frequency cut-offs, and also the bandwidth, of the amplifier.

Q.2 Briefly compare the main parameters of an ideal operational amplifier (op amp) with those of a real device, such as the 741 or 351 op amp. Explain why the input and output impedances of an ideal amplifying device should have the particular values which you list. Give, with labelled resistor values, the circuit diagram of a non-inverting amplifier stage, utilising a single op amp, and with a voltage gain of 20 dB.

State and explain the *Barkhausen Criteria* for sustained oscillation in a closed loop amplifier configuration. Sketch the circuit diagram and explain the operation of either (a) the Phase Shift Oscillator, or (b) the Wien Bridge Oscillator, based on a single op amp amplifying stage.

Q.3 State briefly, without explanation, what the following terms stand for in the field of digital electronics: *TTL, ECL, CMOS, SRAM, DRAM, PROM, EPROM, OTP, Flash memory, MUX.*

Describe the pin-out, operation and facilities of a typical TTL *Data Selector / MUX*, such as the 74xx151 device. Draw up circuit diagrams to show how the 151 is used (a) as a conventional Data Selector, and (b) as a 3-input Truth Table implementer. Use the Truth Table given in Q.4 below to illustrate your answer to part (b).

Q.4 Compare and contrast the internal structure of an 8 bit *microcontroller* (μC) device, such as the INTEL 8051, with that of a general purpose 8 bit *microprocessor* (μP). State the main areas of application of μCs like the 8051, indicating where and why they are preferred over g.p. μPs.

An 8051 system has to implement the Truth Table shown opposite, where P, Q and R are system inputs and X is the single output. Construct a section of 8051 Assembly Language program which will implement this Truth Table. Assume that P, Q and R are wired as lines 0, 1 and 2 on the 8051 I/O port 1, and that X has to be output to line 5 on I/O port 0.

NB: a short 8051 instruction set is appended to this paper.

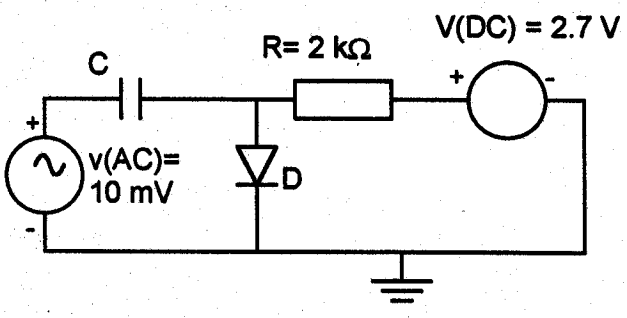
P	Q	R	X
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Q.5 Answer any *TWO* of the following.

(a) Use a diagram to illustrate the physical structure (fabrication) of a npn BJT (Bipolar Junction Transistor). Explain briefly how and why the BJT acts as a CCCS (Current Controlled Current Source). Give its circuit symbol, and sketch its typical output characteristics. Define the quantities α, β and f_T, as applied to BJT's. State typical values for these parameters.

(b) Give the circuit diagram for an *Emitter Follower* circuit, and prove that its voltage gain is very close to one. What are the other important properties of this unity gain circuit, which make it useful in practical circuit design? Explain.

(c) Calculate the approximate values of the DC and AC current components in the silicon p-n diode, D, in the circuit shown opposite. The capacitor C may be assumed to have negligible impedance at the frequency of the AC generator.



Explicitly state any assumptions you make about the diode in your calculations.

A = Accumulator ACC
B = Additional B register
Pn = 8 bit I/O Port 0-3
Rn = Register 0-7 of selected register bank
#data = immediate 8 bit data
rel = 2's compl 8 bit relative jump (-128 to +127)
@Ri = 8 bit address held in R0 or R1
bit = Directly addressed bit (e.g. P0.5, B.7, 7Fh)
<byte> = generalised 8 bit quantity (e.g. one of A, B, Rn, Pn, @Ri, etc)

DATA TRANSFER INSTRUCTIONS	
MOV A, Rn	Move Register Rn to A (Move Register)
MOV A, Pn	Move I/O port to A (Move Direct)
MOV A, @Ri	Move contents of RAM address held in **Ri** (i = 0,1) to A (Move Indirect)
MOV A, #data	Move immediate data to A (Move Immediate)
MOV Rn, A	Move A to Rn
MOV Pn, A	Move A to I/O Port Pn
MOV Pn, #data	Move immediate data to I/O Port Pn
MOV Pm, Pn	Move I/O Port Pn to I/O Port Pm
XCH A, Rn	Exchange A and Rn

ARITHMETICAL AND LOGICAL INSTRUCTIONS	
ADD A, <byte>	Add <byte> = B, Rn, Pn, or @Ri to A
ANL A, <byte>	Logical AND <byte> = B, Rn, Pn, or @Ri with A
CLR A	Clear A (all 8 bits) to 0
CPL A	Complement A
DEC <byte>	Decrement <byte> = A, B, Rn, Pn, or @Ri
INC <byte>	Increment <byte> = A, B, Rn, Pn, or @Ri
ORL A, <byte>	Logical OR <byte> = B, Rn, Pn, #data, or @Ri with A
XRL A, <byte>	Logical XOR <byte> = B, Rn, Pn, #data, or @Ri with A

BOOLEAN (BIT) MANIPULATION	
ANL C, bit	Logical AND direct bit with C
ANL C, /bit	Logical AND the complement of direct bit with C
CLR bit	Clear direct bit to 0. E.g. CLR ACC.5 resets bit #5 in A.
CPL bit	Complement direct bit. E.g. CPL 47h, CPL PSW.6, etc
CLR C	Clear Carry C to 0
CPL C	Complement Carry C
MOV bit, C	Move C to direct bit. E.g. MOV P2.1, C copies C to bit #1 on P2
MOV C, bit	Move direct bit to C. E.g. MOV C, B.3 copies bit #3 of B to C
ORL C, bit	Logical OR direct bit with C
ORL C, /bit	Logical OR complement of direct bit with C
SETB bit	Set direct bit to 1. E.g. SETB P0.0 sets bit 0 of Port 0 to 1
SETB C	Set Carry to 1

PROGRAM BRANCHING	
ACALL adr11	CALL subroutine at 11 bit address unconditionally (Absolute Call)
CJNE A,Pn,rel	Compare I/O port Pn with A and Jump (relative) if Not Equal
CJNE A,#data,rel	Compare immediate data with A and Jump (relative) if Not Equal
DJNZ Rn,rel	Decrement Rn and Jump (relative) if Rn is Not Zero
JB bit,rel	Jump (relative) if direct bit is set
JC rel	Jump (relative) if Carry is set (= 1)
JNC rel	Jump (relative) if Carry is Not set (= 0)
JZ rel	Jump (relative) if A is Zero
JNZ rel	Jump (relative) if A is Not Zero
LJMP adr16	Long Jump to 16 bit absolute address
RET	Return from subroutine : pop PC = Program Counter
SJMP rel	Short Jump to relative address (-128 to +127 bytes from current PC)