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GALWAY

SEMESTER 1 (WINTER) EXAMINATIONS 2000-01

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

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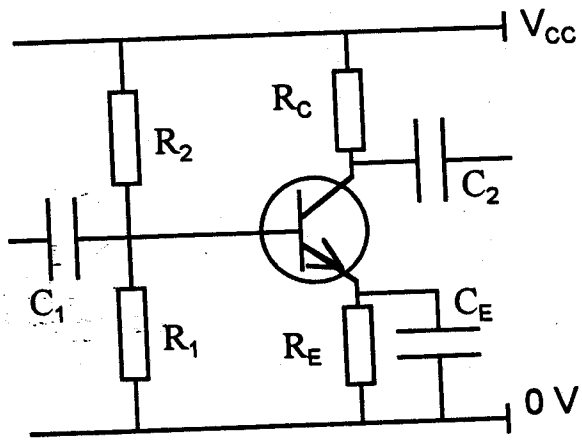
Time allowed TWO hours	Answer THREE questions

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.

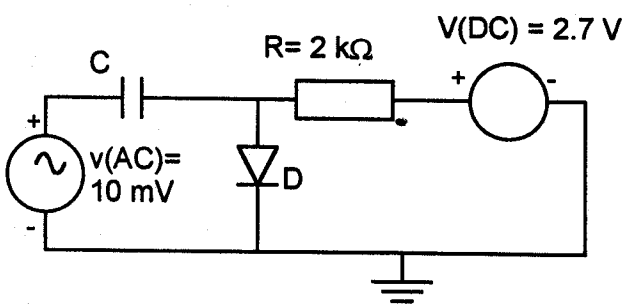
P	Q	R	X
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

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.