PRIFYSGOL ABERYSTWYTH UNIVERSITY

ADRAN FFISEG

DEPARTMENT OF PHYSICS

SEMESTER 2 EXAMINATIONS, MAY 2026

EE11020 – ANALOGUE AND DIGITAL ELECTRONICS

Time allowed – 3 hours

- **Full marks can be attained for complete answers to ALL EIGHT questions in Section A and TWO questions from Section B**
- **The numbers in brackets after the questions indicate the allocation of marks for each question.**
- **Only calculators from the Casio FX83, FX85 or FX991 range may be used.**
- **A booklet of mathematical formulae and standard constants will be provided.**
- **MAE MODD I FYFYRWYR GYFLWYNO ATEBION I'R PAPUR HWN NAILL AI YN Y GYMRAEG NEU'R SAESNEG**
- **STUDENTS MAY SUBMIT ANSWERS TO THIS PAPER IN EITHER WELSH OR ENGLISH**

Once seated, students may complete the front cover of the answer book(s) and the attendance slip ONLY.

DO NOT TURN THE EXAMINATION QUESTION PAPER OVER UNTIL INSTRUCTED TO DO SO.

Section A

Attempt ALL questions in the booklet provided

1 Define each of the following terms and give a suitable example component or circuit for each: [5]

i) Intrinsic semiconductor,

ii) Forward-biased diode,

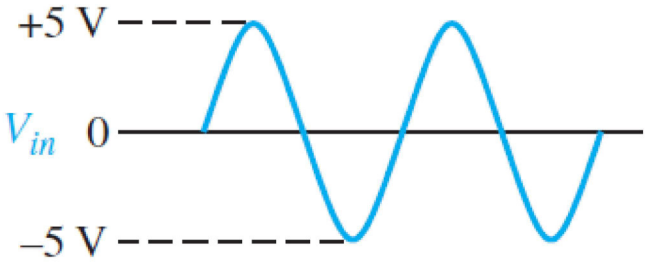
iii) Common-emitter amplifier,

iv) Operational amplifier configured as an inverting amplifier,

v) Logic gate (with one specific example).

2 Sketch and label the output waveforms for a half-wave rectifier and a full-wave bridge rectifier. Explain the main difference in their average output voltages. [5]

Input:



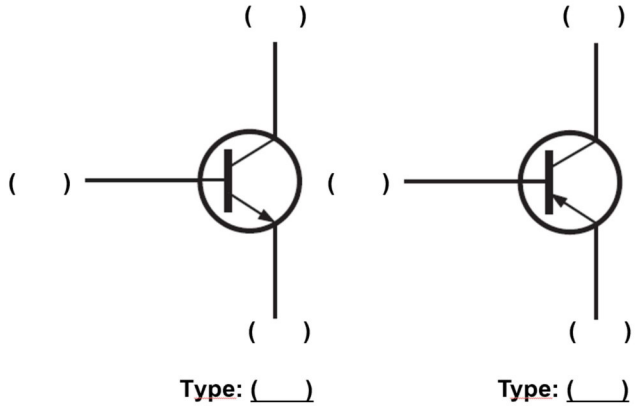
3 The two transistor symbols shown below represent a bipolar junction transistor (BJT). For each symbol: [5]

(i) State whether it is **NPN** or **PNP**. [1]

(ii) Identify the **base (B)**, **collector (C)** and **emitter (E)** terminals. [1]

(iii) Indicate the conventional directions of the base current I_B, collector current I_C, and emitter current I_E. [3]

Redraw the symbols on the answer sheet and label them clearly.



4 Convert any two the following: [5]

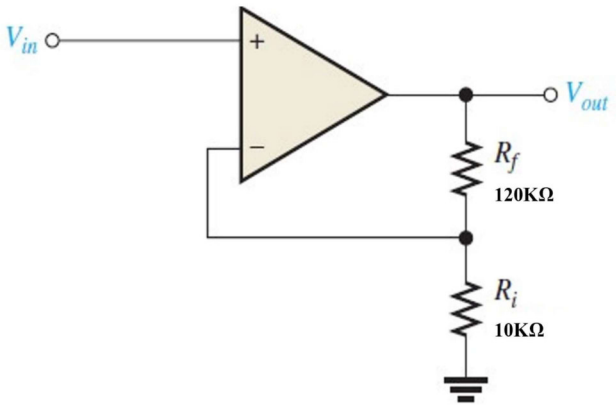
i) $(1101101)_2$ to decimal and hexadecimal.

ii) $(2F)_{16}$ to binary.

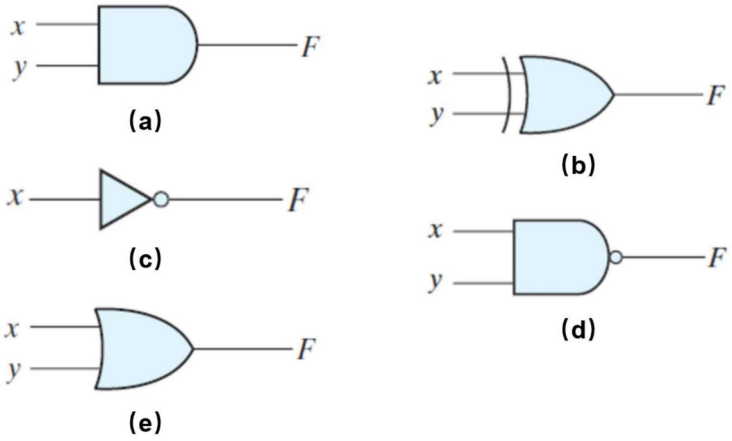
iii) Find the 2's complement of the 6-bit binary number $(100111)_2$.

5 Determine the DC current gain β_{DC} and the emitter current I_E for a transistor where I_B = 50 μA and I_C = 3.65 mA. [5]

6 Determine the closed-loop voltage gain of the amplifier shown below, where $R_f = 120\ k\Omega$ and $R_i = 10\ k\Omega$. [5]



7 Identify the following logic gates. [5]

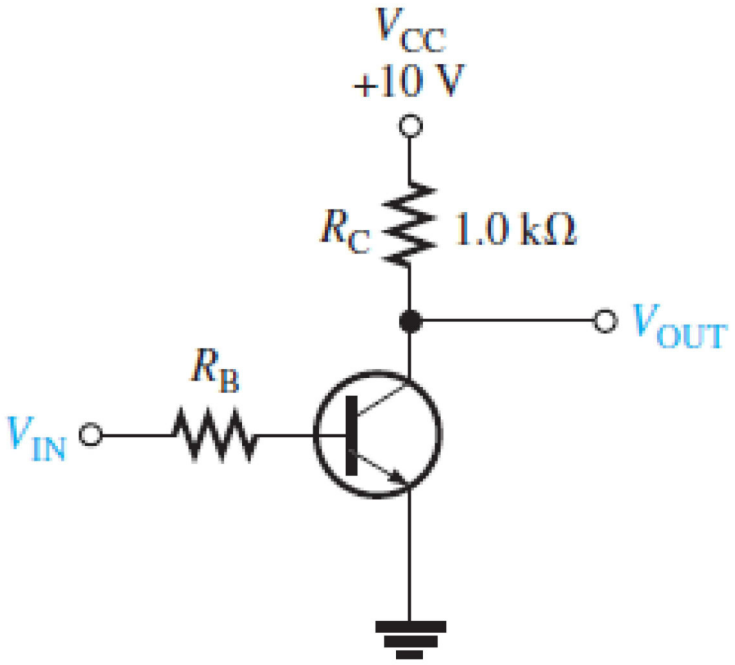


8 Draw the logic diagram of a half adder. [5]

Section B

Answer TWO questions

9 For the transistor circuit shown below:



a) State whether the transistor in the circuit is intended to operate as a switch or as a linear amplifier.

[2]

b) Determine V_{CE} when $V_{IN} = 0V$.

[4]

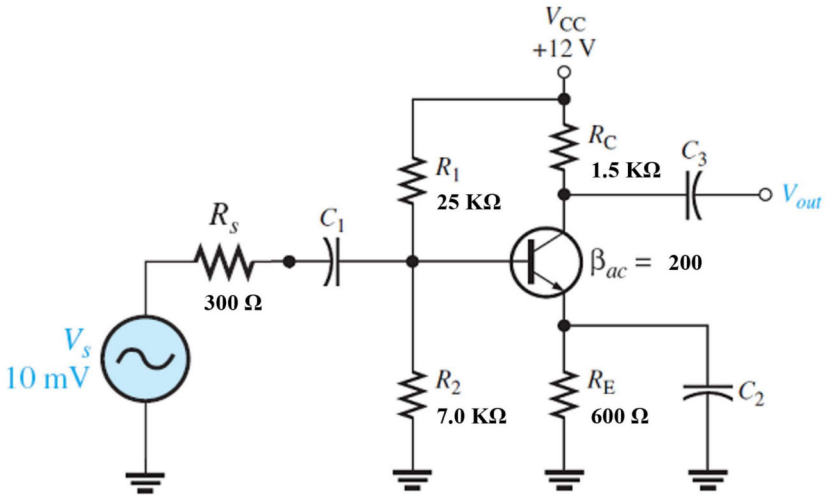
c) Determine the minimum base current required for saturation if $\beta_{DC} = 250$, Neglect $V_{CE(sat)}$.

[6]

d) Calculate the maximum value of R_B for $V_{IN} = 7V$, assuming $V_{BE} = 0.7V$.

[8]

10 For the common-emitter amplifier shown below, assume that the coupling and bypass capacitors act as AC shorts, and that the DC analysis gives $I_E = 3.8$ mA.



a) Draw the AC equivalent circuit of the amplifier.

[8]

b) Calculate the small-signal emitter resistance r_e'.

[4]

c) Determine the voltage gain A_v of the amplifier.

[4]

d) Express the voltage gain in decibels (dB).

[4]

11 Using Karnaugh-map minimisation, simplify the Boolean function

$$\boldsymbol{F(A, B, C, D) = \Sigma(0, 1, 2, 5, 8, 9, 10)}$$

and express the result in:

a) Sum-of-products (SOP) form.

[6]

b) Product-of-sums (POS) form.

[6]

c) Draw a logic-gate implementation of the simplified function obtained in part (a), and a logic-gate implementation of the simplified function obtained in part (b).

[8]

END OF PAPER