Problem 1 [8 points]
(a) In the following figure, all the transistors are identical. Find the output voltage (Vo) [3 marks]

(b) For the circuit shown in Figure (a), the input is triangular waveform (Figure (b)), sketch the output waveform on the given axis. [2 marks]
c) For the circuit shown, derive an expression for the voltage gain \( \frac{V_o}{V_{in}} \) in term of the frequency and plot the gain in dB against the frequency in KHz on the axis provided below: [3 marks]

![Circuit Diagram]

**Problem 2**

The amplifier shown in the figure derives 10nF capacitor \( C_L \). The transistor beta is 200. Find

a) The mid-band gain [4 marks]
b) Sketch the voltage gain against the frequency for this amplifier. Use step of 10 for the gain
[8 marks]
Problem 3 \[18 \text{ marks}\]
The following circuit shows a class AB output stage. Assume all forward biased junctions have a voltage drop of 0.7. Q1 and Q2 are matched complementary transistors. R1 and R2 are used to ensure class AB operation. \(V_i(t)\) is sinusoidal signal source.

a) If the output power across the 5-ohm resistor is 14 W, sketch approximately to scale the current waveform in Q2. \[3 \text{ marks}\]

b) For Part (a), find the amplifier power efficiency and find the power dissipation in each transistor. \[6 \text{ marks}\]
c) What is the minimum power dissipation in each transistor. [9 marks]
Problem 4

For the given circuit, (β = 25)

a) If the load resistor $R_c = 30$ ohms,
   i) What is the maximum output voltage and current swing that can occur before clipping occurs. [4 marks]

ii) Identify the cause of onset of clipping for this case. [1 mark]

iii) Calculate the average power that can be delivered to $R_c$ before clipping and corresponding efficiency. [6 marks]
iv) Find the average power dissipation in the transistor when the peak sinusoidal output voltage is 5 V. (Given \( \int_0^{2\pi} \sin^2 \theta \, d\theta = \pi \)) [3 marks]

b) What is the maximum possible efficiency with this amplifier, consistent with linear operation, and what value of \( R_c \) is required to achieve this. [3 marks]
c) If the output $V_{ce}$ voltage measured using oscilloscope is given by the following graph, find the harmonic components and the second harmonic distortion in the amplifier.

[5 marks]
Problem 5 [only for students who did not attempt the midterm exam] [20 marks]

For the circuit shown,

a) Draw the small-signal equivalent circuit. [4 marks]

b) Find the midband total voltage gain. [4 marks]
c) Find the midband $R_{in}$ and $R_{o}$. [4 marks]
d) Find the low cutoff frequencies. Don’t solve for the one associated with $C_2$. [6 marks]