# UNIVERSITY OF SWAZILAND

## FACULTY OF SCIENCE
**Department of Electrical and Electronic engineering**

# MAIN EXAMINATION 2018

Title of the paper:
**Analogue Design II**

Course Code: EE**323**
Time allowed: **Three Hours**

Instructions:
1. To answer, pick any 5 from the 6 questions in the following pages.
2. The answer must be written in the space provided in the question book; those in elsewhere considered invalid. Use the answer book as a scratch pad. Both question and answer book must be handed-in and marked with name and ID.
3. This paper has 7 pages, including this page.

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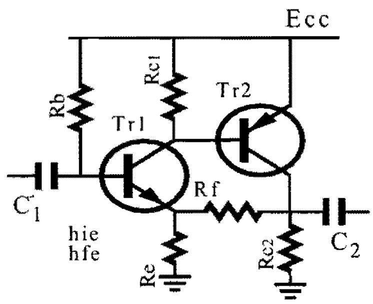
PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

**Q1: (20 pts)** (i) Draw the equivalent circuit of the schematic on the right. (ii) Write the matrix of the equivalent circuit. (each 10 pts) What is the configuration of this 2-stage amplifier (extra 5 pts). Assume the two Tr's are of the same spec.



**Q2: (20 pts)** Give 2 examples of positive feedback circuit in schematic diagram, (i)(7 pts). wideband feedback and (ii)(7 pts). narrowband feedback. (iii)(6 pts) Compare the differences of the output voltage time trace.

**Q3: (20 pts)** 2N3055 has a power dissipation rating 140 Watts at case temperature 25°C, a maximum junction temperature 200°C. (i) (10pts) Study the relationship between the power dissipation rating, $P_D$, and case temperature, $T_C$. Draw the curve $P_D$~$T_C$. (ii)(5 pts) Design a practical heat sink to dissipate the heat to the air at a temperature 25°C. Assume the transistor case and heat sink have a perfect thermal contact. Case temp may be around 45°C; calculate the sink $\theta_{ca}$ , where ca is between the case and the air. (iii)(5 pts) Find the new power dissipation again.

**Q4: (20 pts)** Given Vs=1 $V_{rms}$, the $g_m$ of the FET, 12 mMho in the circuit, and all components values marked in the circuit.

(i)(6 pts) Calculate the FET power output to the speaker under a direct-coupled speaker load 16 Ω.

(ii)(7 pts) Use an emitter follower ($h_{ie}$=1K, $h_{fe}$= 100) as the matching device (not an exact maximum power match) to the load 16 Ω. Draw the schematic circuit.

(iii)(7 pts) Find the new power output to the speaker.

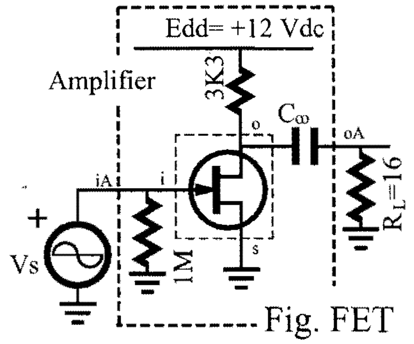


Fig. FET

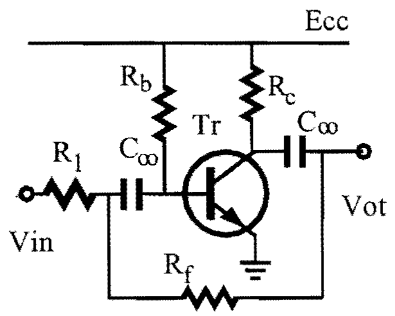
**Q5: (20 pts)** Class AB bias design:

(i)(10 pts) Draw the $V_{be}$ multiplier bias schematic circuit with the bias Tr. $Q_1$, and the pair of the power Tr. $Q_p$, and $Q_n$.

(ii)(5 pts) The circuit constants are: the bias constant current $I_{bias}$=4 mA, $I_Q$=3 mA ($I_c$ of $Q_p$ and $Q_n$, $I_s=10^{-13}$ A) and the small bias Tr $Q_1$ of $I_s=10^{-14}$ A and $V_T$=25mV. Design $V_{be1}$

(ii) (5 pts) Design $R_1$, and $R_2$. Neglect $I_b$ of $Q_1$, $Q_{p,n}$.

**Q6: (20 pts)** A Darlington Tr linear feed-back amplifier is shown on the right. (i)(5 pts) Identify whether the feedback is positive or negative. (No gauss but mark as in the class lecture) (ii)(5 pts) Find $A_{vo}$ and (iii)(5 pts) $A_{vf}$, and (iv)(5 pts) $\beta$ and check if $\beta = R_1/R_f$. The circuit constants are: $h_{ie}$=3 K, $h_{fe}$= 400, R1=2.2 K, $R_f$=220 K, $R_c$=3.3 K, $R_s$=0, and $R_L=\infty$.




(hint: set $R_f$ symbolical and all the rest numerical, and calculate open loop gain $A_{vo}$ as $R_f \rightarrow \infty$ and $A_{vf}$ as $R_f$=220K ).