# Ministry of Higher Education <br> zing Ialdo Onnuersily of Detroleum \& fllinerals <br> Electrical Engineering Department <br>  <br> <br> وزارة التعــــــيم الهـــــي <br> <br> وزارة التعــــــيم الهـــــي <br> جامعة الملك فهـ للبنرولـوالمعادن <br>  

# INDUSTRIAL ELECTRONICS 

## First Major Exam

EE 445 - Winter 2008 (072)

Sunday, March $16^{\text {th }}, 2008$<br>$20 \mathrm{H} 00-21 \mathrm{H} 30$ (1 hour - 30 minutes)

Name
Student ID $\qquad$

## Examiner - Dr. Alaa El-Din Hussein

> This exam contains three questions and is composed of 5 pages including this cover page. Partial point distribution is indicated between brackets. Please pace yourself accordingly.
$>$ This is a CLOSED book examination.
> Make sure to state all assumptions you find necessary to complete your answer.
$>$ Show all your work. Partial credit will be given. If you think you need something that you can't remember, write down what you need and what you'd do if you remembered it.

| Question \# | Question 1 | Question 2 | Question 3 | Total |
| :--- | :--- | :--- | :--- | :--- |
| Mark |  |  |  |  |
| Total Mark | 20 | 20 | 20 | 60 |

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## Question 1:

[20 Marks]
For the shown SCR circuit, the supply is a $\mathrm{DC}=100 \mathrm{~V}$. The SCR has an $\mathrm{I}_{\mathrm{GT}}$ of 20 mA . Assuming that the gate current can't be neglected.
a) Calculate $\mathrm{R}_{2}$ to cause a firing after 2 ms from closing the switch. [5 Marks]
b) If $R_{2}$ is set to be $1 \mathrm{k} \Omega$, calculate the firing delay after closing the switch. [5 Marks]
c) What is the minimum and maximum delay that can be achieved by changing $\mathrm{R}_{2}$. [5 Marks]
d) Sketch the gate and capacitor currents for the case in part b and indicate all the critical levels. [5 Marks]


## Question 2:

For the shown UJT relaxation oscillator, the unijunction transistor has the following characteristics $\eta=0.5, \mathrm{r}_{\mathrm{BB}}=7 \mathrm{k} \Omega, \mathrm{V}_{\mathrm{v}}=1.5, \mathrm{I}_{\mathrm{P}}=5 \mu \mathrm{~A}$, and $\mathrm{I}_{\mathrm{v}}=4 \mathrm{~mA}$. The supply voltage $\mathrm{V}_{\mathrm{cc}}=15 \mathrm{~V}$.
a) Calculate $\mathrm{V}_{\mathrm{P}}$. [2 Marks]
b) Draw the voltage waveform across the capacitor $\mathrm{C}_{\mathrm{E}}$. [2 Marks]
c) Drive an expression for the oscillation frequency. [6 Marks]
d) Calculate the oscillation frequency. [2 Marks]
e) Calculate the minimum and maximum frequency achieved by this circuit assuming the capacitor value is fixed at $0.1 \mu \mathrm{~F}$. [ 6 Marks]
f) What is the effect of changing $\eta$ on the frequency of oscillation? [2 Marks]
[20 Marks]


## Question 3:

For the shown 555 circuit the supply volatge $V_{c c}$ is set to 15 V .
a) Draw the waveform at the trigger input and at the output. [4 Marks]
b) Drive an expression for the frequency of oscillation. [8 Marks]
c) Calculate the output frequency, and the duty ratio for the shown circuit. [4 Marks]
d) What is the function of the control voltage pin?. [2 Marks]
e) Suggest an application of this circuit using the control voltage input. [2 Marks]
[20 Marks]



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