ECE 520 | Hw #1 | Solutions

#1

$$\text{Yield} = \frac{\text{\# of good chips per wafer}}{\text{Total \# of chips per wafer}}$$

(I) $\text{Wastage}_{\%} = \left[1 - \text{Yield}\right] \times 100\,\%$

$$= \left[1 - \left[\frac{\text{die per wafer} \times \text{die area}}{\text{area of the wafer}}\right]\right] \times 100\,\%$$

(1) $\text{die per wafer} = \dfrac{\pi \times \left(\dfrac{\text{wafer diameter}}{2}\right)^2}{\text{die area}} - \dfrac{\pi \times \text{wafer diameter}}{\sqrt{2 \times \text{die area}}}$

(2) $\text{die area} = (\text{die size})^2$

(3) $\text{area of the wafer} = \pi \left(\dfrac{\text{wafer diameter}}{2}\right)^2$

⇒ Plug eq 1, 2 & 3 in (I) to solve for wastage area as a function of die size.

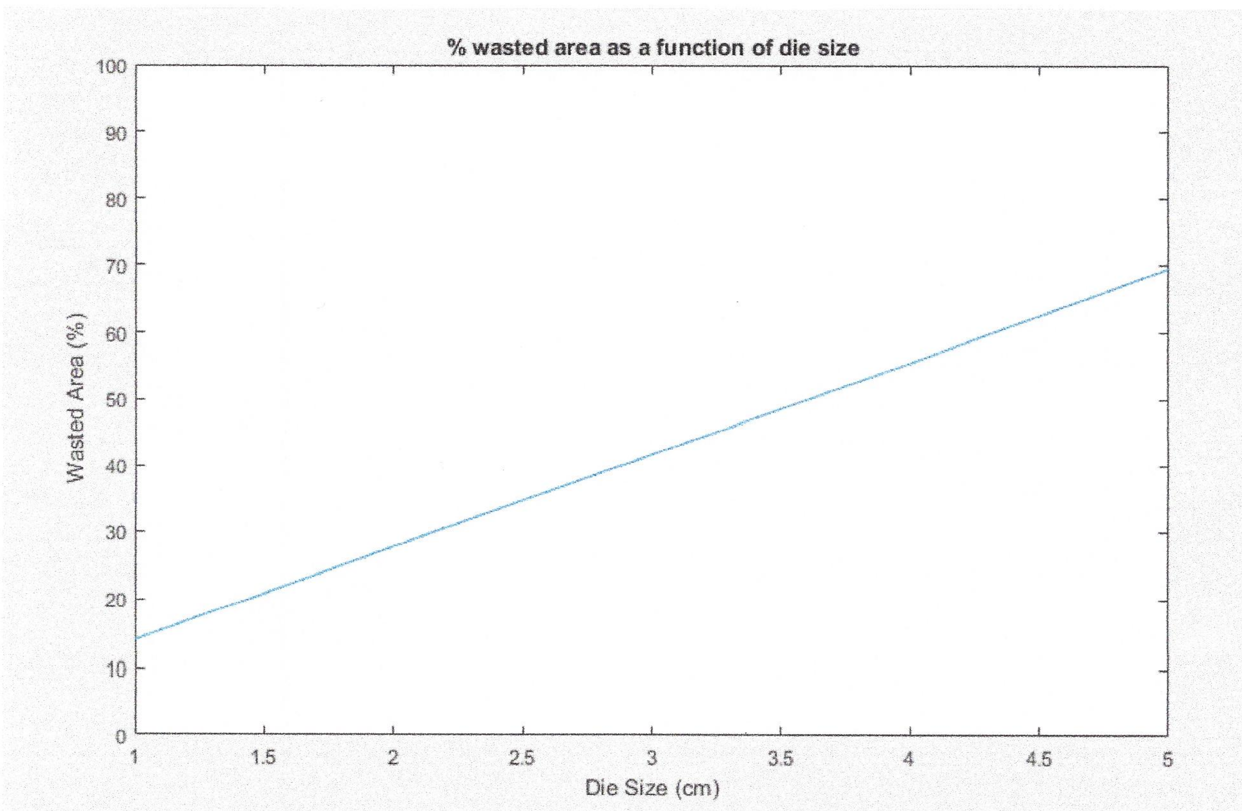
☆ See Matlab code / Results

```
clear all;
close all;
clc;
syms  ds wd dpw pw

ds = 1:0.1:5 ; % die size form 1 to 5 cm
wd = 20.32;    % wafer diameter 8 in = 20.32 cm
dA = ds.^2; % die area
wA = pi*(wd/2)^2 ; % wafer area

dpw = wA./(dA) - (pi*wd)./(sqrt(2*dA)); % die per wafer
pw =  (1-(dpw.*dA)/wA) * 100; % percent of wasted area

figure; plot(ds,pw) % plot die size vs percent of wasted area
 title('% wasted area as a function of die size'), xlabel('Die Size (cm)'), ylabel('Wasted Area (%)')
axis([1 5 0 100])
```



#2

- Show how $I_D = \frac{k'n}{2}\frac{W}{L}(V_{GS} - V_T)^2$ becomes $I_D = I_D'(1 + \lambda V_{DS})$ when channel length modulation is included. Assume $\frac{\Delta L}{L} = \lambda V_{DS}$

⇒ Channel lenght modution redoced lenght

$$L = L - \Delta L$$

so,
$$I_D = \frac{k'n}{2}\left(\frac{W}{L - \Delta L}\right)(V_{gs} - V_t)^2$$

$$= \frac{k'n}{2}\left[\frac{W}{L\left(1 - \frac{\Delta L}{L}\right)}\right](V_{gs} - V_t)^2$$

$$\Downarrow \approx \frac{W}{L}\left(1 + \frac{\Delta L}{L}\right)$$

$$= \frac{k'n}{2}\left(\frac{W}{L}\right)(V_{gs} - V_t)^2\left(1 + \frac{\Delta L}{L}\right)$$

↑ sub-in the given assumption

$$I_D = \frac{k'n}{2}\left(\frac{W}{L}\right)(V_{gs} - V_t)^2(1 + \lambda V_{DS})$$

$$\Rightarrow I_D = I_D'(1 + \lambda V_{DS})$$