

Q1 = 8  
 Q2 = 7  
 Q3 = 5

EECE 480 Assignment 3

2011

1(a) 
$$I_L = I_{ph} - I_0 \left( e^{V_L/V_T} - 1 \right) \rightarrow I_0 = \frac{I_{ph}}{e^{V_{oc}/V_T} - 1}$$

[1] 
$$I_0 = \underline{5.75 \text{ pA}}$$

[1] (b) 
$$I_L = I_{ph} - I_0 \left( e^{V_D/V_T} - 1 \right)$$

$$V_L = V_D - I_L R_s$$

$$I_{ph} = 40 \times 10^{-3} \times A$$

$$A = \pi \times 10^2 / 4 = 78.54 \text{ cm}^2$$

[8] 
$$I_{ph} = 3.14 \text{ A}$$

[1] Plot using MATLAB or equivalent

[1] (c) 
$$P = V_L I_L$$

[1] Plot using MATLAB or equivalent.

(d) 
$$|P_{mp}| = 1.8595 \text{ W}$$

[1] 
$$FF = \frac{P_{mp}}{I_{ph} V_{oc}} = \frac{1.8595}{3.14 \times 0.7} = 0.846$$

[1] 
$$\eta = \frac{P_{mp}}{1000 \times A} = \underline{23.7\%}$$

2a) 
$$R = \frac{L}{\delta A} = \frac{L}{A} \frac{1}{q n \mu} = \frac{L}{W d q n \mu} \quad d = 200 \text{ nm}$$

$$\mu (5 \times 10^{19}) = 91.6 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1} \quad (5.27)$$

[2] 
$$R = \frac{14.66 \times 10^{-4}}{1 \times 200 \times 10^{-7} \times 1.6 \times 10^{-19} \times 5 \times 10^{19} \times 91.6} = \underline{0.1 \Omega}$$

[1] 2b) Use equation in 1 (b)

[1] See plot

[1] 2c) Use equation in 1 (c)

[1] See plot

(d) New  $|P_{mp}|$  from the new  $P-V_L$  plot is 1.025 W

[1] 
$$\therefore \eta = \frac{P_{mp}}{1000 \times A} = 13.05\%$$

[1] 3(a) 
$$\lambda = 743 \text{ nm} \quad E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{743 \times 10^{-9} \times 1.6 \times 10^{-19}} = 1.67 \text{ eV}$$

$$E_g(x) \text{ for AlGaAs} = 1.424 + 1.247x$$

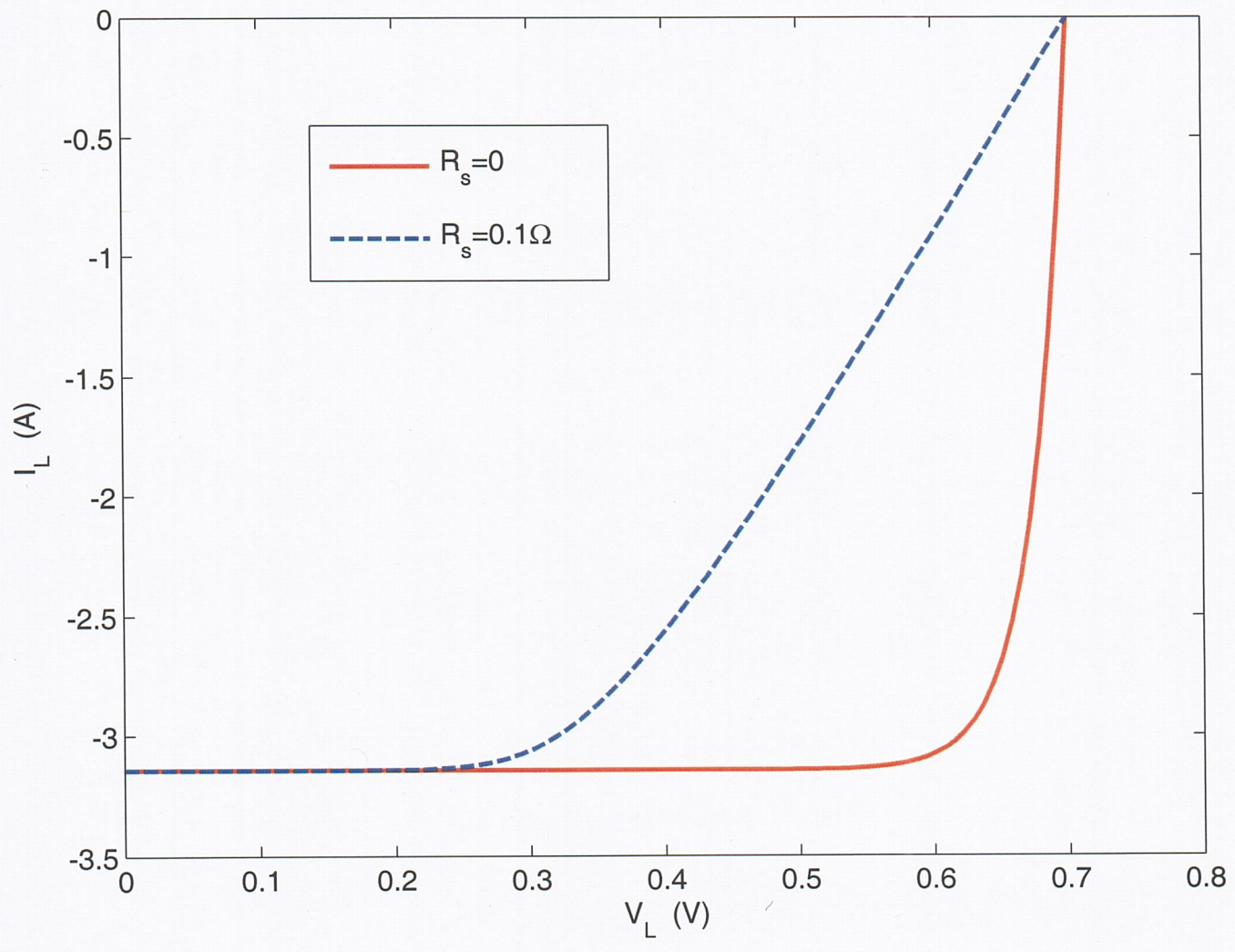
[1] 
$$\therefore x = (1.67 - 1.424) / 1.247 = \underline{\underline{0.2}}$$

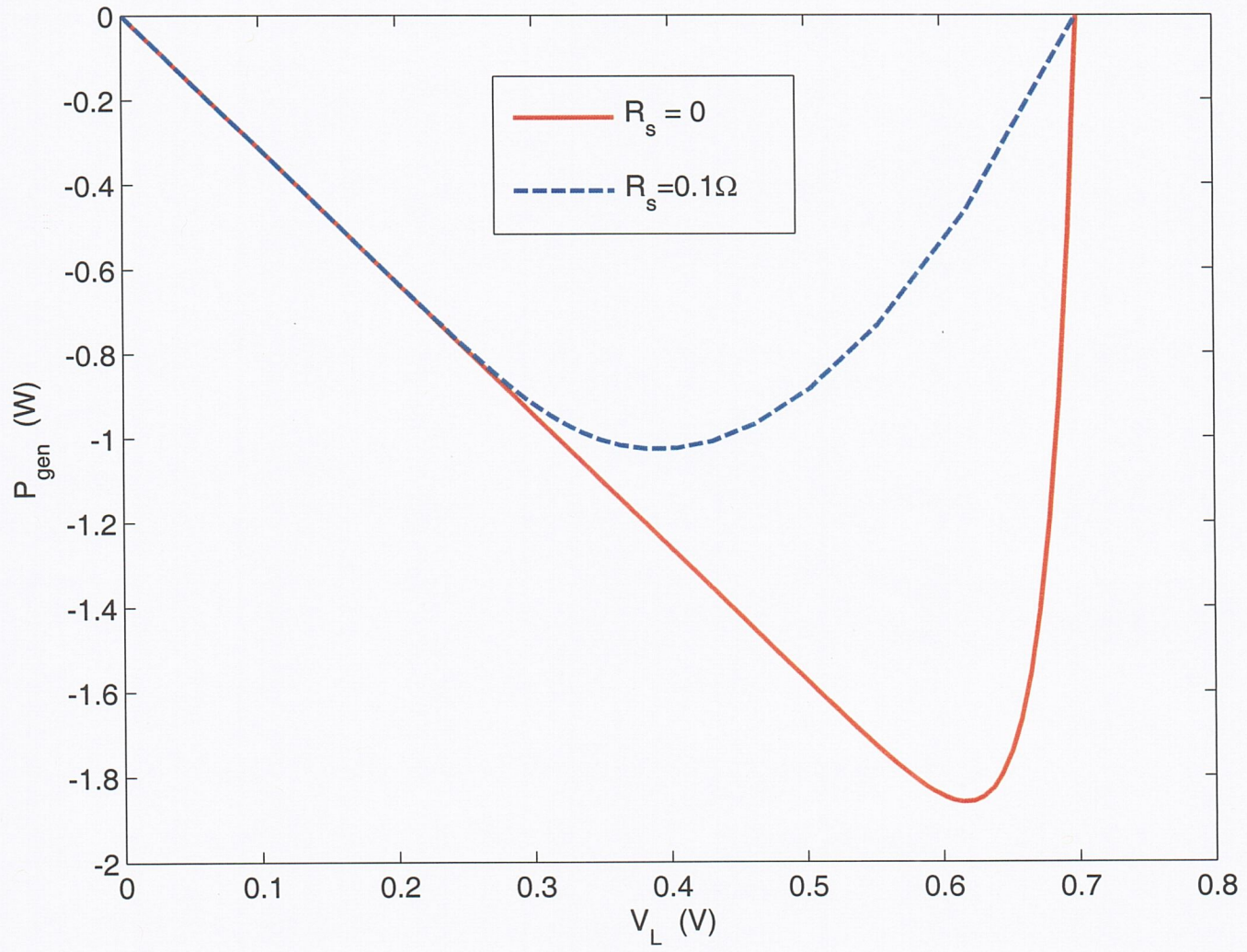
From fig 8.3, need  $In_{0.49}Ga_{0.51}As$  to lattice match

[1] i.e.,  $y = \underline{\underline{0.49}}$

b) 
$$\eta_v = \frac{h\nu}{qV_a}$$

[1] 
$$\therefore V_a = \frac{1.67}{0.96} = \underline{\underline{1.74 \text{ V}}}$$





```
Title "InGaP_AlGaAs_LED"  
T = 300.0;  
mesh = 0.005 um;  
Substrate = GaAs;  
Terminals: anode, cathode;  
LeftBoundary anode ohmic;  
0.1 um, InGaP{In 0.49} [Ptype = 1.0E19 percm3] anode;  
0.1 um, AlGaAs{Al 0.2} [Ptype = 5.0E16 percm3] (h)anode (e)cathode;  
0.1 um, InGaP{In 0.49} [Ntype = 1.0E19 percm3] cathode;  
RightBoundary cathode ohmic;
```

[1]

