UNIVERSITY OF NEW SOUTH WALES
SCHOOL OF PHYSICS - PHYSICS OF SOLID STATE DEVICES
2003 Session II Assignment 2
Date of availability 24 October 2003 due date 5 November 2003.

PHYS9310 & PHYS3310

Question 1 (50%)

(i) Draw a cross-sectional diagram of a typical n-channel MOSFET.

(ii) In about 10-15 lines, explain the principle of operation of the MOSFET, illustrating your answer with band diagrams for the "on" and "off" states.

(iii) In no more than 1 side of A4, explain the key differences between the BJT, the MOSFET, the MESFET, the HEMT and the JFET, and describe the relative advantages of each..

Question 2 (50%)

(i) Draw a band-diagram for a p-n junction under sufficient forward bias that it emits light. What determines the wavelength of the light emitted, and how can this be tuned in practice ?

(ii) For a forward biased LED, the photon flux is given by:

$$\Phi = \eta_i R V = \eta_i \frac{V\Delta n}{\tau} = \frac{V\Delta n}{\tau_r}$$

where $\eta=\tau/\tau_r$ is the internal quantum efficiency, R is the electron injection rate per unit volume, V is the active volume of the LED, n is the electron density and τ_r and τ are the radiative and total exciton lifetimes respectively.

Derive these relations, showing how each parameter is introduced.

(iii) What is the meaning of the threshold current density $\mathbf{J_{th}}$ for a semiconductor laser, and why is it lower in DHJ lasers than in homojunction lasers ?