

NANOTECHNOLOGY THIRD YEAR PHYSICS  
University of Sydney  
Nanophotonics Assignment question  
Professor Ben Eggleton

Lecture notes and slides are available at:

<http://www.physics.usyd.edu.au/cudos/> (bottom of the page)

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Assignment marked out of 20 marks.

(a) Starting with the well-known Maxwell's wave-equation derive the time-**dependent** coupled mode equations (Equations 1.3 -- 1.6 in the Coupled mode notes). Show all steps in your derivation.

Follow the steps in the coupled mode notes: Section 1.21

(8 marks)

(b) Assuming harmonic time dependence (Equation 1.26 in Coupled mode notes) derive the time-**independent** coupled mode equations. Include all steps in the derivation.

(3 marks)

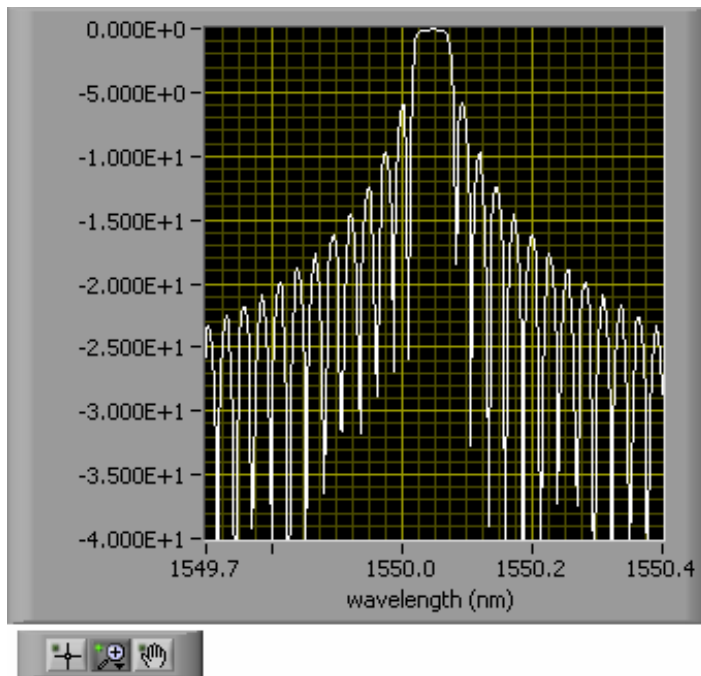
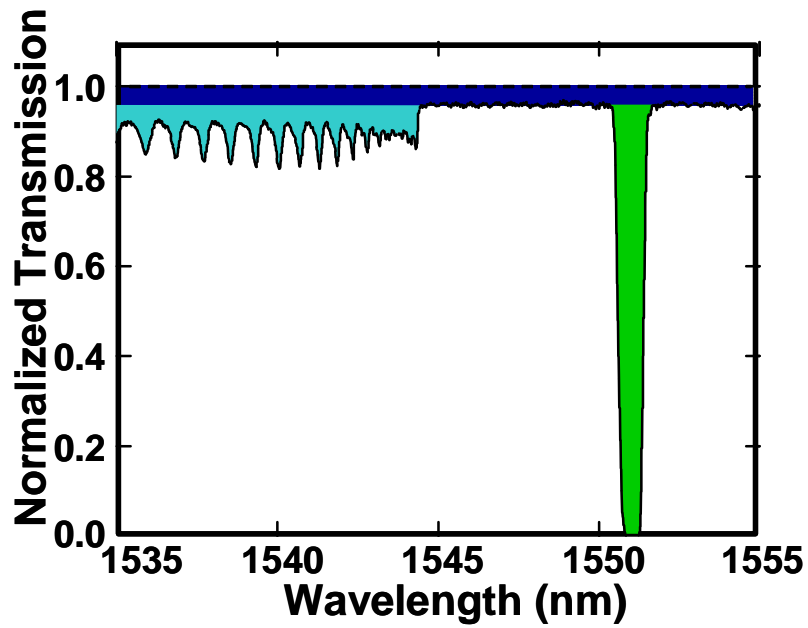
(c) The dispersion relation for an infinite uniform Bragg grating can be obtained by inserting a plane-wave solution (Equation 1.8 in coupled mode notes) into the time-dependent coupled mode equations. Derive the dispersion relation ( $\omega$  versus  $k$ ) for an infinite uniform Bragg grating and plot the resulting functional form that relates the local wavenumber ( $k$ ) and local frequency ( $\omega$ ).

(3 marks)

(d) Discuss some of the interesting physical effects that occur near the edge of the photonic bandgap.

(2 marks)

(e) Discuss some of the differences between the idealized "infinite" structure considered in the analysis above and a realistic "finite" Bragg grating. Refer to the features in the transmission and reflection spectra shown below.



(2 mark)

(f) An optical fibre Bragg grating is located in the core of an optical fibre. Describe 3 different approaches for dynamically tuning the Bragg wavelength of the grating (after the grating has been fabricated).

(2 mark)