EECS 275B
Final exam
Open notes, open book
Friday, March 18, 2005 7-9 pm

1A	1B	1C	2A	2B	Total
/20	/20	/10	/25	/25	/100

1) For the intensity vs. time measured below (schematic) from a mode-locked laser, determine:
   a. Gain-bandwidth of the gain medium

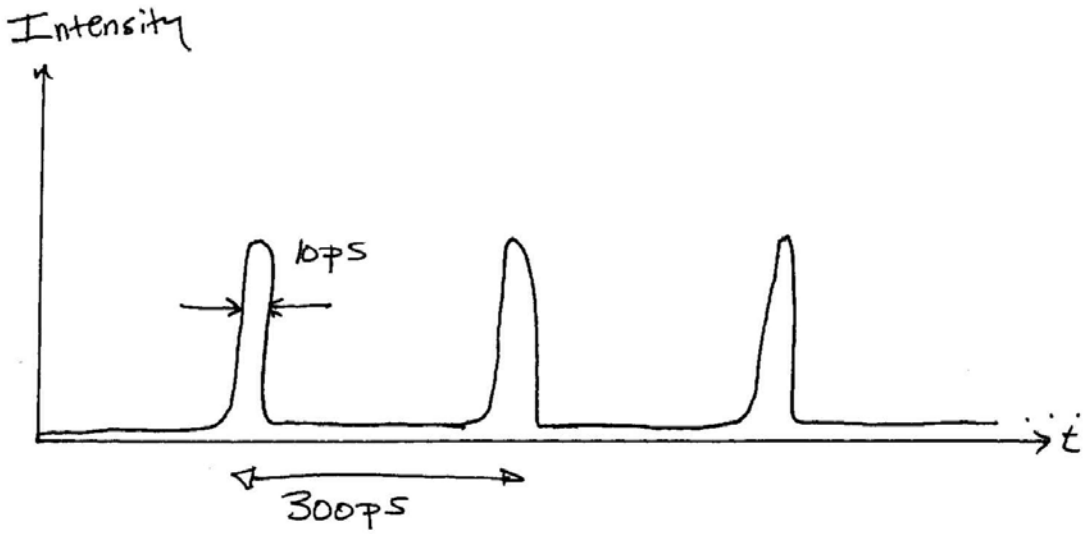
$$\Delta f \approx \frac{1}{10\,ps} = 10^{10}\,Hz$$

   b. Spacing between mirrors

2L/c = 300 ps => L= 0.045 m

   c. Is the broadening homogeneous, or inhomogeneous?

inhomogeneous.



2) A semiconductor diode laser draws 10 mA of current and lases at 1.55 microns.
   a. If the wall-plug efficiency is 100%, what is the optical output power? Hint: Assume that each electron that flows through the circuit generates one optical photon.

I = 10 mA => # e/s = 10^{-2} C/s/1.6x10^{-19} C = 6.25 x 10^{16} electrons/s

 # photons/second = # electrons/second
power = (# photons/second) x (energy/photon)
energy/photon = hf = hc/λ = 6.6x10^{-34} J-s x 3x10^{8} m/s / 1.55x10^{-6} m = 1.28x10^{-19} J

power = (6.25x10^{16} 1/s)x(1.28x10^{-19} J)=0.008 J/s = 0.008 W

   b. Determine the efficiency (optical power out divided by electrical power in) of the laser diode model Agere D4323P. This is the one where we handed out data sheets for in class. The important table from the data sheet is shown below. L_F is the laser out put power when V_{LF} is the voltage applied. Assume "typical" operating conditions.

Optical power out (typ) = 40 mW
Electrical power in (typ) = I x V = 350 mA x 1.5 V = 0.525 W

Efficiency = 0.04 W/0.525 W = 7.6%

Minimum and maximum values are testing requirements. Typical values are device characteristics and are results of engineering evaluations; they are for information purposes only and are not part of the testing requirements. All specifications in Tables 2 and 3 are tested at beginning of life (BOL) unless otherwise specified.

Table 2. D2543P-Type Electrical Characteristics (at 25 °C laser temperature)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Threshold Current	I_{TH}	—	—	20	50	mA
Drive Current	—	L_F = 40 mW	—	350	400	mA
Laser Forward Voltage	V_{LF}	L_F = 40 mW (CW)	—	1.5	2.0	V
Monitor Reverse-bias Voltage*	V_{RMON}	—	3	5	10	V
Back-facet Monitor Current:	I_{RMON}	P_O = 40 mW (CW)	0.15	2	3	mA
Monitor Dark Current	I_D	I_F = 0, V_{RMON} = 5 V	—	0.01	0.1	µA
Input Impedance	Z_{IN}	—	—	25	—	Ω
Thermistor Current	I_{TC}	—	10	—	100	µA
Resistance Ratio†	—	—	9.1	9.6	10.1	—
Thermistor Resistance	R_{TH}	T_L = 25 °C	9.5	—	10.5	kΩ
Laser Submount Temperature	T_{LASER}	—	20	—	35	°C
TEC Current	I_{TEC}	T_L = 20 °C, T_C = 70 °C	—	—	1.8	A
TEC Voltage	V_{TEC}	T_L = 20 °C, T_C = 70 °C	—	—	3.5	V
TEC Capacity	ΔT	T_C = 70 °C	50	—	—	°C

* Standard operating condition is 5.0 V reverse bias.
† Ratio of thermistor resistance at 0 °C to thermistor resistance at 50 °C..