EECS277C Spring 11 **Midterm #2** Name: Solns.

5/17/2011 3:30 to 4:50 pm ID no.:______________

Professor Peter Burke

1	2	3	4	5	6	Total
/10	/40	/20	/10	/10	/10	/100

Helpful constants for you:

$c = 3\ 10^8$ m/s
$e = 1.6\ 10^{-19}$ coulombs
$h = 6.63\ 10^{-34}$ J-s
$m = 9.1\ 10^{-31}$ kg
$k_B = 1.38\ 10^{-23}$ J/K
$h/e^2 = 25\ k\Omega$

1) [10 pts.] Approximately what is the Fermi energy for electrons in metals such as gold, aluminum, copper, etc?

10eV

2) [40 pts.] Which of the following systems shows resistance quantization?

Quantized resistance?	***Yes***	***No***
Ballistic, wide, long wire	X	
Ballistic, narrow, long wire	X	
Ballistic, wide, short wire	X	
Ballistic narrow, short wire	X	
Diffusive wide long wire		X
Diffusive narrow long wire		X
Diffusive wide short wire		X
Diffusive narrow short wire		X

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3) [20 pts.] For those systems that do show resistance quantization, what is the resistance if the wire is wide enough to support one mode? (Be sure to take into account the fact that electrons have spin.) Express your answer in ohms!

$\frac{h}{2e^2} = 12.5\ k\Omega$

4) [10 pts.] Two different quantum dots are connected to leads with small tunnel barriers. The conductance of the leads vs. gate voltage for one quantum dot (quantum dot A) shows clear peaks at temperatures below 100 K. The conductance vs. gate voltage for the other quantum dot (quantum dot B) shows clear peaks at temperature below 10 K. Which dot is smaller, A or B?

A

5) [10 pts.] In class we had a demonstration tunnel junction with two Al electrodes separated by a thin oxide tunnel barrier. The Al electrodes were about 1 cm x 1 mm x 100 nm. Are the electrodes 1d,2d, or 3d in the quantum mechanical sense?

3D

6) [10 pts.] A ballistic wire has a long length, but the height is one Fermi wavelength tall, and the width is 10 Fermi wavelengths wide. What is the resistance?

$\frac{h}{2e^2}\frac{1}{10} = 1.25\ k\Omega$