# Final exam day 5

## Problem 1

### M. Marchevsky, (Unit 2 and Unit 3)

#### 2 points



## Problem 2

### S. Prestemon (Unit 4 and Unit 7)

#### 2 points

Explain why in a superconducting strand, the superconductor is present in the form of small filaments.

## Problem 3

### E. Todesco (Unit 10-11)

#### 4 points

As shown in exercise 1.1, an LHC lattice with quadrupole spacing *L*=150 m would allow an energy increase of 5% but would require an aperture increase in the dipoles from 56 to 83 mm.

1. Assuming that the LHC dipole are made with a sector coil of 30 mm width and neglecting the grading, compute the increase in the quantity of conductor needed to increase the aperture from 56 to 83 mm. *(1 point)*
2. We now assume that the quadrupole spacing is kept at 150 m, but the the energy is kept as in the LHC, and therefore the dipole field is reduced by 5% to compensate for the higher filling factor. Assuming the same current density as in the LHC dipoles, compute the coil width required to obtain the 5% lower field. Estimate the quantity of conductor with this coil width and the 83 mm aperture. Is it larger or smaller than the quantity needed for the LHC dipoles ? *(3 points)*

## Problem 4

### P. Ferracin (Unit 9-12)

#### 1 points

Compute the magnetic pressure in MPa of a thin walled, infinitely long solenoid producing a central field of 8 T.

## Problem 5

## E. Todesco (Unit 15 and Unit 16)

#### 6 points

The accelerator shown in the Terminator-II movie has a 5.76 TeV energy, a bending radius of order of 30 m, and a tunnel diameter of about 4 m. The Terminator T-1000 gets blocked on the dipole cryostat due to the fringe fields.

1. Compute the magnetic field of the dipole ; *(1 point)*
2. Assuming that the coil width is 20 cm, estimate the overall current density ; *(1 point)*
3. Verify that the thickness of the iron needed to totally shield the magnet, i.e. to avoid fringe fields in the tunnel, is not compatible with the tunnel size (Note : you have to make a reasonable assumption on the aperture radius); *(1 point)*
4. Assuming that there is no iron to shield the magnetic field, estimate the magnetic field on the cryostat, assuming that its diameter is 1 m, and verify if it is larger than 3 mT, a safety value given to avoid that ferromagnetic objects are driven by the magnetic field. *(3 points)*

## Problem 6

### M. Marchevsky, (Unit 17)

3 points



