Student No.: ______________________

Qualifying/Placement Exam, Part-A
10:00 – 12:00, Aug. 20, 2018, 1400 BPS

Put your **Student Number** on every sheet of this
6 problem Exam -- NOW

You have 2 hours to complete the 6 problems on Part-A of the exam. Show your work! Full credit will not be given for answers without justification. Some partial credit may be earned for the correct procedure, even if the correct answer is not achieved. Answers must be in the spaces provided. The **BACK** of the problem page may be used for lengthy calculations. *Do not use the back of the previous page for this purpose*!

You may need the following constants:

$k_e = 8.99\times10^9\ \mathrm{Nm^2/C^2}$	permittivity of free space
$\sigma = 5.7\times10^{-8}\ \mathrm{Wm^{-2}K^{-4}}$	Stefan-Boltzmann constant
$k = 1.4\times10^{-23}\ \mathrm{J/K}$	Boltzmann constant
$\hbar = 1.05\times10^{-34}\ \mathrm{J\cdot s}$	Planck's constant
$= 6.58\times10^{-16}\ \mathrm{eV\cdot s}$	"
$c = 3.0\times10^8\ \mathrm{m/s}$	speed of light
$e = 1.602\times10^{-19}\mathrm{C}$	charge of the electron

Student No.: ________________________

1. [10 pts] The vectors $\mathbf{v}_1 = (1,1,0)$, $\mathbf{v}_2 = (1,0,1)$, $\mathbf{v}_3 = (0,1,1)$, form a complete set of basis vectors, i.e., one can find a unique linear combination of these vectors to represent an arbitrary vector (x, y, z):

$$(x, y, z) = c_1\mathbf{v}_1 + c_2\mathbf{v}_2 + c_3\mathbf{v}_3 .$$

a) [5 pts] Prove that this linear combination is unique.

b) [5 pts] Determine the components, c_1, c_2, c_3, of the general vector (x, y, z).

Student No.: ________________________

3. [10 pts] Find the eigenvalues and eigenvectors of the matrix:

$$M = \begin{pmatrix} 1 & 2 & 0 \\ 2 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

4. [10 pts] The National Ignition Facility (NIF) has the most powerful laser in the world. NIF uses 192 beams to aim 500 TW of power at a spherical target of diameter 2.00 mm with density 2000 kg/m^3.

Suppose that *only one* of the 192 laser beams hits the target for 1.00 ns and the target *absorbs only* 2.00% of the laser light.

a) [7 pts] What is the radiation pressure (the absorbed power per unit area, divided by the speed of light) on the target.

b) [3 pts] What is the resulting acceleration of the target?