

PHY102: Quiz 1

Full marks : 20

Time 45 mins.

1. Calculate divergence and curl of the following vector **(10 points)**

$$\vec{V} = e^{3x} \sin y \hat{i} + \frac{\cos^2 y}{1 + 5y^2} \hat{j} + \tan y \log z \hat{k}.$$

2. Suppose we are in two dimensions. We have  $x$  axis and  $y$  axis. The unit vectors along positive  $x$  and positive  $y$  directions are  $\hat{i}$  and  $\hat{j}$  respectively. Now we make a coordinate transformation and go to  $(r, \theta)$  coordinate system. The coordinates of these two coordinate systems are related by,

$$x = r \cos \theta \quad \text{and} \quad y = r \sin \theta.$$

The unit vectors in  $(r, \theta)$  coordinate system are given by  $\hat{r}$  and  $\hat{\theta}$ .  $\hat{r}$  is the direction along which  $r$  increases keeping  $\theta$  fixed and  $\hat{\theta}$  is the direction along which  $\theta$  increases keeping  $r$  fixed. Look at the figure on the last page. Find the relation between  $(\hat{r}, \hat{\theta})$  and  $(\hat{i}, \hat{j})$ . **(10 points)**