Motilal Nehru National Institute of Technology Allahabad

GIS Cell

End Semester (Even) Examination 2018

Session 2017-18

Programme: B. Tech. (All branches)

Semester: 8th

**Course:** Fundamentals of LiDAR technology **Course Code:** GI1882

**Time:** 03 hrs **Max Marks:** 60

**Instructions:**

1. Attempt all the questions and their subparts should be answered at one place.
2. Answers should be brief and to the point.
3. Any missing data may be suitably assumed and mentioned.

**Q.1: Answer the following questions.** (5+5+7)

(a) What are the different components of airborne laser scanning (ALS) system? Explain the working of each component briefly?

(b) How LiDAR technology helps in accurate budget estimation of road widening and coal mines related projects?

(c) Write down the four main characteristics of laser beam generated by laser transmitter of laser scanner, which require for three-dimensional (3D) mapping? Explain why these characteristics of laser beam are chosen for 3D mapping?

**Q.2: Answer the following questions.** (3+3+4)

(a) Calculate area and shape of laser footprint in ALS, if flying altitude = 1 km, diameter of laser transmitter = 10 cm, and wavelength of laser pulse = 1048 nm.

(b) Write down the categories of LiDAR system based on its mounting platform and laser scanner's range measurement technology? An application of each category should also be written?

(c) What is the role of positioning and orientation system (POS) in case of LiDAR based scanning from moving platform. Explain with help of vector algebra?

**Q.3: Answer the following questions.** (3+4+2)

(a) Can laser scanning be performed for point coordinate measurement using a pulse generated in microwave spectrum? Discuss in detail in support of your answer using mathematical approach.

(b) Derive an equation to compute range resolution and maximum range in case of continuous wave laser scanning?

(c) List the different coordinate systems used in the airborne laser scanning?

**Q4: Answer the following questions.** (7+7)

(a) Derive equations to compute along-track and across track one-dimensional (1D) point densities, that is line densities using flight planning parameters and laser scanner parameters? What is the condition to achieve uniform 2D point density?

(Note: Use unidirectional scanning pattern)

(b) Three different orthogonal right handed coordinate systems $CS_1$ ($X_1Y_1Z_1$), $CS_2$ ($X_2Y_2Z_2$), and $CS_3$ ($X_3Y_3Z_3$) are given. If a vector $P_0$ is given in $CS_1$ and it equal to $2\hat{X}_1+6\hat{Y}_1+3\hat{Z}_1$. Compute this vector in $CS_3$, if $\angle X_1X_2 = 30^0$, $\angle Y_1Y_2 = 0^0$, $\angle Z_1Z_2 = 15^0$, $\angle X_2X_3 = 45^0$, $\angle Y_2Y_3 = 20^0$, $\angle Z_2Z_3 = 0^0$ and $O_1O_3 = 10\hat{X}_3+9\hat{Y}_3+8\hat{Z}_3$, where X, Y, Z, and O represent X-axis, Y-axis, Z-axis, and origin, of a coordinate system, respectively.

**Q5: Answer the following questions** (8+2)

(a) Calculate the energy of received laser pulse at receiver in laser scanning using the following parameters values.

Peak transmitted power ($P_T$) = 2 kW, laser beam divergence ($\gamma$) = $10^{-3}$ rad, range (R) = 750 m, Target diameter within the laser footprint ($D_{tar}$) = 70 cm, Diameter of transmitter and receiver aperture ($D_t$ and $D_r$) = 10 cm, Atmospheric transmission (M) = 0.8, Target reflectance ($\rho$) = 0.5, and laser pulse width ($t_{pulse}$)= 10 ns.

(b) Compute the number of photoelectrons generated by received reflected laser pule energy using detector quantum efficiency ($\eta$) = 0.7, and laser wavelength = 1064 nm. Plank constant (H) = $6.626\times10^{-34}$ Js.