

REMOTE SENSING
(AEIE 6134)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group - A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Remote sensing uses which of the following waves in its procedure?
(a) Electric field (b) Gamma rays
(c) Sonar waves (d) Electro-magnetic waves.
- (ii) Which of the following is not a reason why remote sensing is ideal for use in physical geography?
(a) It can monitor change over time
(b) It can be applied at any scale
(c) It will always be more reliable than fieldwork studies
(d) It minimizes the need for fieldwork in dangerous, isolated and sensitive areas.
- (iii) The correct sequence of transmission of electromagnetic waves in remote sensing system can be given as _____
(a) Energy source, transmission of signal, propagation of signal
(b) Transmission of signal, propagation of signal, energy source
(c) Propagation of signal, transmission of signal, energy source
(d) Energy source, propagation of energy, transmission of signal.
- (iv) The instruments which provide electromagnetic radiation of specified wave length or a band of wave lengths to illuminate the earth surface are called
(a) Sensors (b) Passive sensors
(c) Active sensors (d) None of (a), (b) & (c).
- (v) The procedure in which individual pixel values of a digital image gets altered is called
(a) Neighbourhood Operations (b) Image Registration
(c) Geometric Spatial Transformation (d) Single Pixel Operation.
- (vi) The spectral region of the electromagnetic radiation which passes through the atmosphere without much attenuation is known as
(a) Ozone hole (b) Atmospheric window
(c) Ozone window (d) Black hole.

- (vii) Which of the following is the definition of 'parallax'?
- (a) The fading, disturbance or degradation of a signal from surface reflectance caused by signals from unwanted sources
 - (b) A mathematical method for fitting a model to data so as to minimize error between the observed values and the estimated values
 - (c) The apparent change in position of an object when viewed from two different positions
 - (d) The area on the ground covered by the remote sensing instrument.
- (viii) A 1:50,000 scale map can be compared to the following spatial resolution:
- (a) 50000m
 - (b) 50m
 - (c) 1/50000m
 - (d) Not possible to compare.
- (ix) K-means clustering is a
- (a) Supervised learning
 - (b) Unsupervised learning
 - (c) Semi-supervised learning
 - (d) Reinforcement learning.
- (x) In the process of image classification, which of the following methods results in a greater accuracy of classes within an image actually matching land use patterns on the ground?
- (a) Manual/supervised by a user
 - (b) Robotic classification
 - (c) Fully automated
 - (d) Unprocessed image interpretation.

Fill in the blanks with the correct word

- (xi) In hyperspectral remote sensing, the EM spectrum is _____.
- (xii) LIDAR is the acronym of _____.
- (xiii) A 512×512 image of 8 bits would require _____ MB of computer memory to store it.
- (xiv) The length of the terrain strip remotely sensed by the system during one complete across-track sweep of the scanning mirror is known as _____.
- (xv) The point just vertically below the observer's position, in celestial sphere is called _____.

Group - B

2. (a) Define remote sensing. What are the active and passive remote sensing?
[[CO1](Remember/LOCQ)]
- (b) What are the factors that affect electromagnetic radiance recorded by an optical remote sensing system? Express it as a function of those factors. [[CO1](Understand/LOCQ)]
- (c) Define reflectance, transmittance and absorbance of an object. What is spectral signature?
[[CO1](Remember/LOCQ)]
4 + 4 + 4 = 12
3. (a) Describe energy matter interactions in the atmosphere. What is spectral signature?
[[CO1](Remember/LOCQ)]
- (b) What is Rayleigh scattering? Why sky appears red during sunset? [[CO1](Remember/LOCQ)]
- (c) If temperature of a blackbody is 3000 K, calculate the radiance of that material for the wavelength $5 \mu\text{m}$.
[[CO2](Apply/IOCQ)]
4 + 4 + 4 = 12

Group - C

4. (a) What are vertical and oblique aerial photography? What is scale of such aerial photographs? On which factors the scale of a photograph depends? *[[CO3](Remember/LOCQ)]*
- (b) A vertical aerial photograph shows two features to be separated by 4.5 inch. A map at scale 1:24,000 shows the same two features to be separated by 9.3 inch. Calculate the scale of the photograph. *[[CO3](Evaluate/HOCQ)]*
- (c) What are range resolution and azimuth resolution? How enhanced azimuth resolution is obtained in synthetic aperture radar? *[[CO2](Analyse/IOCQ)]*
- 4 + 4 + 4 = 12**
5. (a) What is emissivity of an object? Discuss the factors that influence emissivity of an object. *[[CO2](Understand/LOCQ)]*
- (b) For the measurement of height of a tower let the relief displacement for the tower is 3.05 mm and the radial distance from the centre of the photo to the top of the tower is 65.58 mm. If the flying height is 1200 m above the base of the tower, find the height of the tower. *[[CO3](Evaluate/HOCQ)]*
- (c) What is Ground Swath Width (GSW) of across track thermal infrared scanning system? If a sensor system has total angular field of view of 100° and an altitude above ground level of 8000 m, find the GSW of this system. *[[CO2](Analyse/LOCQ)]*
- 4 + 4 + 4 = 12**

Group - D

6. (a) Describe the k nearest mean filter, median filter and adaptive median filter. *[[CO4](Understand/LOCQ)]*
- (b) Apply the above three filters and find out the filtering results considering a 3×3 mask for the marked pixel with a circle on the sample image shown in Fig. 1 below. Articulate merits of the filters based on the filtering results. *[[CO4](Apply/IOCQ)]*

138	113	140	173	100
144	18	145	18	97
167	96	122	152	146
173	87	134	83	126
167	119	98	112	123

Fig. 1

- (c) List the points under what circumstances geometric corrections of remotely sensed image are required. *[[CO5](Understand/LOCQ)]*
- 4 + 6 + 2 = 12**
7. (a) What is a point operation in image processing? Give the mathematical definition. *[[CO5](Remember/LOCQ)]*
- (b) Given the following point operation functions, develop the output histograms $h_o(y)$ from the input histogram $h_i(x)$: $y = 3x - 5$; $y = 3.5x^2 - 3x + 4$; $y = 0.8\sin x$. *[[CO5](Evaluate/HOCQ)]*
- (c) Derive an expression of Laplacian filters used for the rate of change of gradient in image. *[[CO4](Analyse/IOCQ)]*
- 3 + 6 + 3 = 12**

Group - E

8. (a) What is a confusion matrix? Based on the confusion matrix, give definitions for overall accuracy, user's accuracy and producer's accuracy. [[CO6](Understand/LOCQ)]
- (b) In a classification problem of water (W), sand (S), forest (F), urban (U), corn (C) and hay (H), the following confusion matrix is obtained as shown in Fig. 2. Based on this results evaluate overall accuracy, user's accuracy, producer's accuracy and kappa coefficient (κ). [[CO6](Apply/IOCQ)]

		Reference Data					
Classification Data		W	S	F	U	C	H
W		226	0	0	12	0	1
S		0	216	0	92	1	0
F		3	0	360	228	3	5
U		2	108	2	397	8	4
C		1	4	48	132	190	78
H		1	0	19	84	36	219

Fig. 2

4 + 8 = 12

9. (a) Differentiate between supervised and unsupervised learning. [[CO6] (Remember/LOCQ)]

- (b) In a classification problem, a three dimensional feature vector $X = \begin{bmatrix} 2 \\ 3 \\ 1 \end{bmatrix}$ is to be classified by means of the following set of discriminant functions.

$$g_1(x) = 2x_1 + x_2 + 0.5x_3 + 1$$

$$g_2(x) = x_1 + 2x_2 + x_3 - 2$$

$$g_3(x) = 0.5x_1 + 0.5x_2 + 3x_3 - 1$$

Evaluate in which class X belongs to? [[CO6] (Analyse/IOCQ)]

- (c) The discriminant functions for a 2-class problem in 2-dimensional space are given by

$$g_1(x) = 2x_1 + x_2 + 1.5 \quad g_2(x) = 1.5x_1 + 2x_2 - 1.$$

(i) Write the equation for the decision boundary between the two classes.

(ii) For two pixels $X_1 = \begin{bmatrix} 3 \\ 1 \end{bmatrix}$ and $X_2 = \begin{bmatrix} 1 \\ 4 \end{bmatrix}$, find their correct classes. [[CO6](Analyse/IOCQ)]

3 + 5 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	50	35.4	14.6

Course Outcome (CO):

After the completion of the course students will be able to

1. Understand and describe the key theoretical components involved in the remote sensing data collection process such as, energy sources, energy-terrain-atmosphere interactions, platforms and sensor resolution characteristics spanning multispectral and hyperspectral.
2. Gain knowledge of thermal remote sensing, active microwave remote sensing such as RADAR, LIDAR and synthetic aperture RADAR.
3. Perform photogrammetric calculations such as scale factor, height, area, etc. from vertical aerial photographs.
4. Learn essential image processing techniques such as image enhancement, restoration and filtering of noise, etc.
5. Carry-out basic arithmetic operations and correction procedures such as geometric, radiometric and atmospheric corrections on image.
6. Acquire knowledge of machine learning techniques of remote sensing data analysis.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.