Marks scored:

KATHMANDU UNIVERSITY
End Semester Examination
March/April, 2017

Level : B.E.
Year : III
Course : GEOM 317
Semester : I
Exam Roll No. :
Time: 30 mins.
F. M. : 20
Registration No.:
Date :

SECTION "A"
[20 Q × 0.5 =10 marks]

Average Radius of the Earth *= 6371km*
Gravitational Constant *= 6.67 * $10^{-11} Nm^2/kg^2$*
Semi-major axis of WGS84 Ellipsoid *= 6378137.0 m*
Semi-major axis of EVS1830 Ellipsoid *= 6377299.365 m*
Inverse flattening of WGS84 Ellipsoid *= 298.257223563*
Inverse flattening of EVS1830 Ellipsoid *= 300.80172554*

Choose the best alternatives among the given choices:

1. The latitude defined as the angle between the plane of equator and the line joining the center of the earth and the point itself is:
   a. Geodetic latitude
   b. Reduced latitude
   c. Geocentric latitude
   d. Astronomical latitude

2. Residual is the
   a. Difference between two measured value
   b. Difference of two correct value
   c. Mean of two measured value
   d. Difference between any measured value of quantity and its most probable value.

3. What is geodetic datum?
   a. Latitude and longitude of Nagarkot base point origin
   b. The data point that defines the location of Greenwich
   c. A theoretical map project designed to provide accurate scale over the entire surface of an oblate spheroid
   d. Set of parameters that define the size and shape of the Earth and the origin of coordinate system that describe positions on the Earth.

4. Plumb lines are
   a. Straight lines
   b. Geoidal lines
   c. Elliptical lines
   d. Curve lines

5. The division of two of first three fundamental coefficients E and G gives
   a. $V^{-4}Sec^2\emptyset$
   b. $C^2 * V^{-4}Cos^2\emptyset$
   c. $V^{-4}Sin^2\emptyset$
   d. $V^{-4}tan^2\emptyset$

6. The shape of the Earth is best described as an / a _____
   a. Perfect sphere
   b. Ellipsoid
   c. Oblate ellipsoid
   d. Prolate ellipsoid

7. On the Earth's surface, the geographic grid consisting of intersecting parallels and meridians are identified by_____, respectively.
   a. Latitudes and longitudes
   b. Longitudes and latitudes
   c. Azimuth and space
   d. Tropic of Cancer, Tropic of Capricorn

8. All meridians converge at points located at the _____.
   a. Equator
   b. Tropic of cancer
   c. Arctic and Antarctic circles
   d. Poles

9. Gravitational potential at a point is defined as the amount of work done in bringing the unit mass from infinity to that point in the gravitational field _____ the gravitational force.
   a. Along
   b. Perpendicular to
   c. Against
   d. Tangent to

10. The plumb line at a point P with geodetic coordinates ($27^0 37' 14.65''$, $85^0 32' 22.34''$) on EVS 1830 ellipsoid is
   a. Perpendicular to the geoid through that point
   b. A line to join zenith of that point
   c. Pass through the center of the Earth
   d. Perpendicular to the ellipsoid at that point

11. The curvature of the ellipse is defined as, the rate of change of
   a. Slope of ellipse w.r.t. the arc length of the ellipse
   b. Arc length w.r.t. the slope of the ellipse
   c. Ordinate w.r.t. the abscissa of the ellipse
   d. Eccentricity w.r.t. the semi-major axis of the ellipse

12. With usual meaning of all the symbols the Sectorial harmonics will be obtained for
   a. $m \neq 0$ and $n=0$
   b. $m \neq n$
   c. $m=n \neq 0$
   d. $m=0$ and $n \neq 0$

13. The length of normal terminating on major axis of WGS84 ellipsoid with 60^0 geodetic latitude is
   a. 6351403.908 m
   b. 6356752.314 m
   c. 6378137.0 m
   d. 6399593.626 m

14. With usual meanings of the symbol in Geodesy; which of the following relationship is true?
   a. $b = a\sqrt{1+e^2}$
   b. $n = \frac{\left(1+\sqrt{1-e^2}\right)^2}{e^2}$
   c. $f = 1-\sqrt{1+e^2}$
   d. $m = \frac{e^2}{2-e^2}$

15. Surface spherical harmonics where m≠0 divides the sphere into alternating positive and negative compartments are known as:
    a. Zonal harmonics
    b. Sectorial harmonics
    c. Compartmental harmonics
    d. Tesseral harmonics

16. The associated Legendre function of a variable for n= 3 and m=2 is
    a. $Sin\theta$
    b. $3Sin^2\theta$
    c. $15Cos\theta Sin^2\theta$
    d. $\frac{1}{8}(3Cos\theta + 5Cos3\theta)$

17. The value of reduced latitude (β) at poles and equator respectively is:
    a. ±90° and 0°
    b. 0° and 180°
    c. 0° and 90°
    d. ±180° and 0°

18. Which one of the following is false for meridians of longitude?
    a. They always meet at the poles
    b. True north-south lines
    c. Each is equal to half the length of a great circle
    d. Always begin with the Prime meridian through Greenwich, England.

19. Angle between normal to geoid and normal to reference ellipsoid is
    a. Geoid undulation
    b. Deflection of vertical
    c. Astronomical Geodetic variation
    d. Datum deficiency

20. If a plane bisected the earth midway between the axis of rotation and perpendicular to it, the intersection with the surface would form a circle called:
    a. Small circle
    b. Auxiliary circle
    c. Concentric circle
    d. Equator

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Level : B.E.
Year : III
Time : 2 hrs. 30 mins.

Course : GEOM 317
Semester : I
F. M. : 40

SECTION "B"

Average Radius of the Earth = *6371km*
Gravitational Constant = $6.67 * 10^{-11} Nm^2/kg^2$
Semi-major axis of WGS84 Ellipsoid = *6378137.0 m*
Semi-major axis of EVS1830 Ellipsoid = *6377299.365 m*
Inverse flattening of WGS84 Ellipsoid = *298.257223563*
Inverse flattening of EVS1830 Ellipsoid = *300.80172554*

Attempt *ALL* questions. Assume suitable data if necessary.

1. Define Geopotential model. Derive a solution for Laplace equation known as spherical harmonic series used to develop Geopotential models of the Earth. Start from Laplacian equation in spherical coordinate system i.e. [1+5]

$$\nabla^2 V = \frac{1}{r^2}\frac{\partial}{\partial r}\left[r^2 \frac{\partial V}{\partial r}\right] + \frac{1}{r^2 Sin\theta}\frac{\partial}{\partial \theta}\left[Sin\theta \frac{\partial V}{\partial \theta}\right] + \frac{1}{r^2 Sin^2\theta}\frac{\partial^2 V}{\partial^2 \lambda}$$

2. If you are given geodetic latitude and eccentricity parameters, how would you derive an expression for computing the length of normal terminating on minor axis of a rotational ellipsoid? Finally use the expression for computing the length of normal terminating on minor axis at 45° latitude on WGS84 ellipsoid. [4+1]

3. What do you mean by Laplace equation? What are the solutions of Laplace equations called? Derive an expression to show that ∇^2 of centrifugal potential is double the angular velocity of Earth; where symbols has got usual meanings in physical geodesy. [1+1+2]

OR

Derive an expression for determining the arc length between two points on the surface of an ellipsoid. Hence use it to find out the surface area of an ellipsoid given the Cartesian coordinates of ellipsoid in terms of latitude and longitude. [3+1]

4. Define geodetic, geocentric and reduced latitude. Given the semi-major axis 'a' and semi-minor axis 'b'. Establish the relationship between the different latitudes (geodetic ϕ, geocentric φ, and reduced β).
Geodetic Reference System GRS80 has got equatorial radius of the ellipsoid of revolution and inverse flattening as 6378137 m and 298.257222101. If reduced latitude β = 45° then compute geodetic and geocentric latitude values in the case of GRS80. [1.5+1.5+2]

5. Answer the following questions regarding different height systems used in Geodesy:
   a. Define Geopotential number. What does it express physically?
   b. Briefly explain dynamic and orthometric heights and finally point out the conceptual difference between these two height systems.
   c. What is the reference surface for orthometric and normal heights?
   d. At point P the potential difference with sea level is $5000 m^2/s^2$. The local gravity is g = 9.820,000m/s^2 and the normal gravity calculated at the level of point P is γ = 9.820,492 m/s^2. [1 m/s^2=100000mGal] Calculate the dynamic height of point P and free air anomaly Δg_{FA} neglecting the parameter 'h'. [1+2+1+1]

6. Write short notes on *ANY FIVE* of the following: [1×5 = 5]
   a. Geodesics
   b. Curvature
   c. Zonal harmonics
   d. Rodrigues Formula
   e. Celestial Horizon
   f. Observer's Meridian

OR

Define Gravimetry. Explain satellite method (GRACE/CHAMP) method of determining gravity variations on the surface of the Earth. Why gravity reduction has to be carried out? [1+3+1]

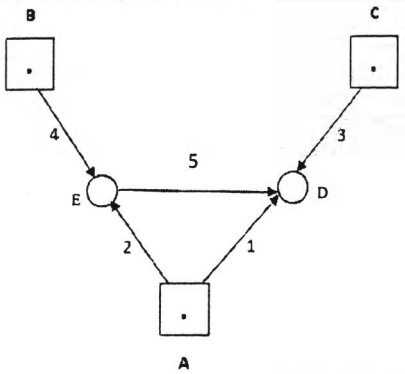
7. Google Earth shows the geographic coordinate of Kathmandu University Central Library as ($27^0$37'14.65'', $85^0$32'22.34''). A surveyor is trying to find the coordinate of same position in local coordinate system i.e. Everest 1830. The values of the transformation (WGS-84 to Everest 1830) parameters according to Survey Department of Nepal are as follows:

Parameters	***Estimated Values***
Translation in X axis (m)	124.3813
Translation in Y axis (m)	-521.6700
Translation in Z axis (m)	-764.5137
Rotation in X axis (Sec)	-17.1488
Rotation in Y axis (Sec)	8.11536
Rotation in Z axis (Sec)	-11.1842
Scale Factor (ppm)	2.1105

   a. Find the rectangular coordinate of KU Library in WGS84.
   b. Transform thus obtained coordinate into EVS1830 in projected coordinate system. **You can use given transformation parameter.**
   c. Find its geodetic coordinate on EVS1830. ***Do at least 2 iterations.***
   d. What do you think would be the accuracy of your transformed coordinates? Will it points the same location if overlaid on newly prepared topographical map of KU based on EVS 1830? [1+2+2+1]

8. Define least square adjustment technique. For the levelling network shown below, find out the most probable elevation values of E and D given the elevation values of Bench marks at A, B and C are 1410.021 m, 1410.321 m and 1411.002 m respectively. [1+3]

Levelling Network



Line	Height Difference (m)	Distance (km)
1	1.978	1.02
2	0.732	0.97
3	0.988	1.11
4	0.420	1.07
5	1.258	0.89