Marks scored:

KATHMANDU UNIVERSITY
End Semester Examination
August, 2018

Level : B.E.
Year : III

Course : GEOM 315
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date AUG 0 8 2018

SECTION "A"
[20 Q × 0.5 = 10 marks]

Choose the best alternatives among the given choices:

1. Imagine another solar system, with a star of the same mass as the Sun. Suppose a planet with a mass twice that of Earth ($2M_{Earth}$) orbits at a distance of 1 AU from the star. What is the orbital period of this planet?
   a. 1 year
   b. 6 months
   c. 2 years
   d. Undefined

2. A satellite of mass 'm' moves in a circular orbit at a speed 'v' and a distance 'r' from the center of a planet of mass 'M'. Which of the following expression gives the total energy of the satellite?
   a. $m\left(\frac{v^2}{r}-\frac{GM}{r}\right)$
   b. $m\left(\frac{v^2}{2}-\frac{GM}{r}\right)$
   c. $m\left(\frac{v^2}{r}+\frac{GM}{r}\right)$
   d. $m\left(\frac{v^2}{2}+\frac{GM}{r}\right)$

3. Which of the following orbits' period of revolution is equal to the period of rotation of the Earth?
   a. Sun synchronous orbit
   b. Polar orbit
   c. Geosynchronous orbit
   d. Molniya orbit

4. Assuming that the symbols carry usual meaning, which of the following relationship is correct?
   a. $y = a\sqrt{1+e^2}SinE$
   b. $y = a\sqrt{1-e^2}SinE$
   c. $x = a\sqrt{1-e^2}SinE$
   d. $x = e\sqrt{1-a^2}SinE$

5. The point where the satellite crosses the equatorial plane on moving from the Southern to the Northern hemisphere is called:
   a. Nodal point
   b. Descending node
   c. Ascending node
   d. Vernal equinox

6. What is the ratio of escape velocity of a rocket launched from sea level and one launched from Mt. Everest (altitude 8.85 km)?
   a. 1.0007
   b. 0.9993
   c. 1.0014
   d. 0.9986

7. Two orbits have semi-major axis of 56AU each. But one of these is a circular orbit, and the other is elliptical. Regarding the orbital periods for the two, which of the following holds true?
   a. The circular orbit has longer orbital period.
   b. The circular orbit has shorter orbital period.
   c. The two have the same orbital period.
   d. The two orbital periods cannot be compared without knowing the eccentricity of the elliptical orbit.

8. If a body is to be projected vertically upwards from the surface of the Earth to reach a height of '5' times the radius **R (6400 km)** of the Earth, the velocity with which it is to be projected is_____.
   a. $\sqrt{\frac{5gR}{4}}$
   b. $\sqrt{\frac{5gR}{3}}$
   c. $\sqrt{\frac{2gR}{5}}$
   d. $\sqrt{\frac{5gR}{2}}$

9. According to what we now know from Newton's laws, which of the following *best* explains why Kepler's second law is true?
   a. A planet's angular momentum must be conserved as it moves around its orbit.
   b. Orbits must be elliptical in shape.
   c. Gravity follows an inverse cube law.
   d. This effect happens because of the influence of other planets on a particular planet's orbit.

10. According to the ionosphere delay model, the delay is maximum at_____.
   a. 14:00 PM
   b. 2 o' clock
   c. 2:00 AM
   d. 2:00 AM – 14:00 PM

11. The allowed shapes for orbits under the influence of gravity is _____.
   a. Ellipses only
   b. Ellipses and spirals
   c. Ellipses, parabolas and hyperbolas
   d. Spirals, circles and squares

12. 3D geographic transformations from Datum A to Datum B without actually converting it to X, Y, Z system is known as:
   a. Molodensky Transformation
   b. Helmert Transformation
   c. Molodensky-Badekas
   d. Bursa Wolf Transformation

13. A communication satellite which takes 24 hours to orbit the Earth is replaced by a new satellite which has twice the mass of the old one. The new satellite also has an orbit of 24 hours. What is the value of $\frac{radius\ of\ orbit\ of\ new\ satellite}{radius\ of\ orbit\ of\ old\ satellite}$?

a. 1/2
b. 2/1
c. 1/1
d. 1/3

14. What would happen if the Space Shuttle were launched with a speed greater than Earth's *escape velocity*?

a. It would travel away from the Earth into the solar system
b. It would orbit earth at faster velocity
c. It would travel in a higher orbit around the Earth
d. It would take less time to reach its bound orbit

15. The maximum velocity of GPS satellite in space with respect to the observer at the ground station (given a = 26000 km and e = 0.01 where symbols carry usual meanings in satellite Geodesy) is _____.

a. 3.877 km/s
b. 38.77 km/s
c. 39.55 km/s
d. 3.955 km/s

16. Galileo satellite system is positioned in _____.

a. 5 circular orbits
b. 6 circular orbits
c. 2 circular orbits
d. 3 circular orbits

17. A planet moves fastest in its orbit

a. When it is closest to the Sun
b. When it is farthest from the Sun
c. The closer it is to its satellites
d. When it is in opposition

18. If the standard meridian for India is 82°30' E, what is the local meantime for the place corresponding to the standard time of 20hr 35m 10s?

a. 20 hr 35 m 10 s
b. 20 hr 25 m 10 s
c. 22 hr 25 m 10 s
d. 18 hr 35 m 10 s

19. The ratio of masses $\frac{M_{Earth}}{M_{Mars}} = 10$ and the ratio of radii $\frac{R_{Earth}}{R_{Mars}} = 2$. What is the best estimate of the ratio of gravitational fields at the surface of the two bodies $\frac{g_{Earth}}{g_{Mars}}$?

a. 1
b. 3
c. 5
d. 7

20. RTCM data format in DGPS surveying stands for _____.

a. Radio Technical Commission for Maritime Services
b. Receiver Time Correction Model
c. Raw Data Timely Correction Module
d. Real Time Correction Model

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SECTION "B"

Eccentricity of GPS satellite orbit = 0.02
Radius of the Earth = 6371 km
$\mu_{Earth} = 398600.4405 \pm 0.001 km^3 s^{-2}$, *Mass of the Earth* $= 5.9722 * 10^{24} kg$
$\mu_{Moon} = 4.9009159 * 10^{12} \pm 0.001 km^3 s^{-2}$, *Radius of Moon = 1737.055 km*
$\mu_{Sun} = 1.33 * 10^{11} km^3 s^{-2}$, $G = 6.67 * 10^{-11} Nm^2 kg^{-2}$, $g = 9.8\ m/s^2$
$1AU/TU_s = 29.784852$ *km/s, 1 DU/TU =* $7.905366149846 km/s$
$1TU_s = 58.132821$ *days, 1DU =* $6378.1363 km$

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

1. Derive Kepler's law of periods with descriptive figure. If a satellite is to be projected vertically upward from the Earth's surface to reach a height of 10 R, at what velocity should it be projected?
The new comet Alex-Casey has a veryelliptical orbit with a period of 127.4 year. If the closest approach of Alex-Casey to the Sun is 0.1 AU, what is its greatest distance from the Sun? [2+1.5+1.5]

2. Describe the types of satellite orbits characterized on the basis of orbital height along with their advantages and disadvantages.
Draw a well labelled diagram showing all Keplerian elements. Fill up the following table with the information as per the table headings: [2.5+1+1.5]

Name	*Range of values*	*Undefined*

OR

What orbital elements are used when there is: a) no perigee (e = 0), b) no ascending node; equatorial orbit (i = 0 or 180°) and c) no perigee and ascending node (e = 0 and i = 0 or 180°)? Compute the Keplerian elements for an Earth-orbiting satellite located at $\vec{r} = (-\sqrt{\frac{1}{2}}, \sqrt{\frac{1}{2}}, 0)$ DU and moving with a velocity of $\vec{V} = (0, \frac{1}{2}, 0)$ DU/TU. [1+4]

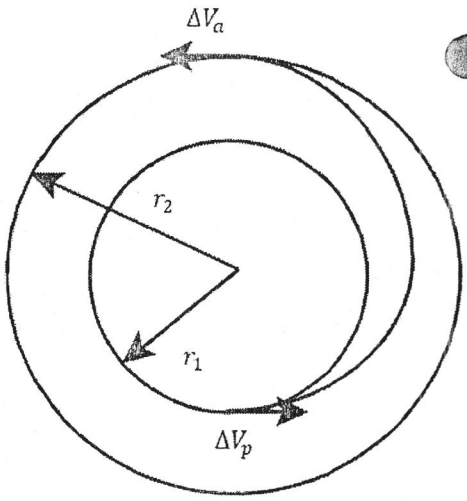
3. Derive an expression for the satellite's position in Earth Centered Earth Fixed Reference (ECEF) Frame. Determine the ECEF coordinate of the GPS satellite if the true anomaly is 70°, argument of perigee is 90° and Right Ascension of Ascending Node (RAAN) is 30°? [3+2]

4. What forces cause deviation in the path and position of the satellite? ***Explain with graphical description of the forces and accelerations involved.*** What approaches are used to solve these perturbed equation problem? Show that the magnitude of solar radiation pressure is $4.56 * 10^{-6} N/m^2$ if satellite absorbs all photons and is perpendicular to the incoming radiations. [1.5+1.5+2]

OR

An artificial satellite ISS (International Space Station) from NASA is moving at a certain height in an elliptical orbit of "372 × 381 km ". How would you determine the path (or orbit) of that satellite which is already moving in space? Mention any one idea in order to track the aforementioned satellite. ***Candidates are required to answer with mathematical expressions as well as facts if any.*** [2.5+2.5]

5. Define Hohmann transfer orbit. A satellite has to be transferred from inner circular orbit (r_1) to outer circular orbit (r_2) as shown in the figure. Explain with the mathematical expressions showing the velocity increments at each of the steps involved.
Consider a flight from the Earth's orbit about the Sun to the planet Uranus' orbit about the Sun. The Earth is in an orbit of 1 AU, and Uranus is in an orbit of 19.28 AU. What ΔV is required to transfer from one orbit to the other? Also, find out the time of flight (TOF). ***The velocity increment should be expressed in terms of km/s and TOF in years.***



[1+2+2]

6. Describe how GPS helps in fixing 2D and 3D coordinates of a point on the Earth with GPS receiver. Explain the entire process with increasing number of GPS satellites. ***Your answer must state possible locations of GPS receiver when satellite number goes from one to four satellite.*** Shortly explain about selective availability as well as anti-spoofing. Mention one advantage of the two. [2+1+2]

7. Bhaktapur Municipality wants to use DGPS RTK (Real Time Kinematics) to do road inventory survey. As a surveyor what are the challenges that hinders the accuracy of this survey work and what steps would you undertake to overcome the challenges? Explain working mechanism of Ground Based Augmentation System (GBAS) with the help of system architecture. ***Your answer should focus on how the GPS position is improved with the help of GBAS.*** [3+2]

8. How is time difference between two countries calculated? The standard meridian changes with $7^0 30'$ as a result of which central meridian for Nepal is $82^0 30'$ which seems to be ineligible for Nepal. What is the main reason of it? Explain what steps have been taken in order to overcome the problem.
A flight from London to Nice departed on 4 August, 2018 at 13:00. One of the client is in doubt if she took off at 1:00 PM from London, would she be able to pick up her children from school at 5:00 PM (local time) in Nice? Flight duration from London to Nice is 2 hours. The airport at London lies at 15°W of Greenwich. Nice is at GMT: +2:00 hour. [2+3]