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Continuing Education Course #211
Mechanics of Attitude Control for Spacecraft

1. Spacecraft attitude can refer to its orientation with reference to which of the following?
- a. its body
- b. inertial space
- c. its orbit
- d. all of the above

2. Spacecraft attitude control is the ability of a spacecraft to maintain or change its orientation to some desired position with respect to some reference.
- a. True
- b. False

3. Spacecraft attitude can be perturbed (changed) by which of the following?
- a. environmental disturbances
- b. spacecraft mass distribution
- c. spacecraft thermal snap (flexing)
- d. all of the above

4. Which orbital type has the same period as the earth, making the satellite seem like it is fixed in space relative to earth; ideal for communications satellites?
- a. geosynchronous (GEO)
- b. low earth orbit (LEO)
- c. highly elliptical orbit (HEO)

5. Which spacecraft reference frame is most similar to that used by an airplane?
- a. inertial
- b. body
- c. orbital

6. Suppose a satellite has a perfect yaw attitude (i.e. spacecraft W axis is perfectly aligned with orbital axis O sub 3. What would the direction cosine (value) W sub 3 of the attitude matrix (A) be?
- a. 0
- b. 0.707
- c. 1

7. Which three-axis attitude parameterization uses 3 angles: roll, pitch, and yaw to quantify the attitude?
- a. direction cosine matrix
- b. Euler angles
- c. Euler angle and Euler axis
- d. quaternion

8. Single-axis attitude can be described by which of the following?
- ○ a. a nine element Direction Cosine Matrix only
- ○ b. Euler angles - roll, pitch, yaw only
- ○ c. quaternion only
- ○ d. 1) declination and right ascension or 2) three direction cosines

9. Of what significance is it to find the principle moment of inertia for a spacecraft?
- ○ a. it reduces the number of values from 9 to 3; making it simpler for analysis
- ○ b. it is a symmetrical representation of the inertia matrix
- ○ c. a and b

10. Angular velocity is a function of the moment of inertia of the spacecraft.
- ○ a. True
- ○ b. False

11. What input(s) to some control methods are critical from determination methods - necessary for controlling the spacecraft?
- ○ a. angular positions
- ○ b. angular rates
- ○ c. a and b

12. How many reference vectors are needed - minimum, when using vector algorithms for attitude determination?
- ○ a. 1
- ○ b. 2
- ○ c. 3
- ○ d. 4

13. Which onboard spacecraft sensor(s) is/are used to measure vector directions to a reference source?
- ○ a. sun
- ○ b. star
- ○ c. earth magnetic
- ○ d. all of the above

14. The scanning type _______________ has the unique ability to determine the pitch and roll (Euler) attitude angles independent of any other sensor or algorithm. Note: Gyroscopes (rate and rate integrating sensors) also have this ability, but can also determine the third - yaw angle.
- ○ a. sun
- ○ b. star
- ○ c. earth magnetic
- ○ d. triad, QUEST, or q
- ○ e. horizon sensor

15. Rate and rate integrating sensors (aka _____________) use mechanical, optical, or electrical principles to measure angular velocities (rates) and angular positions (rate integrating).
- ○ a. gravity gradient booms
- ○ b. mass expulsion thrusters
- ○ c. magnetic torque rods
- ○ d. gyroscopes
- ○ e. radial and axial jets

16. Which algorithm uses prediction as a key element to estimate the attitude?

○ a. triad
○ b. q
○ c. Kalman filter
○ d. QUEST

17. For single-axis attitude measurements, what method(s) can be used to fix the attitude vector?
○ a. arc-length measurements
○ b. arc-length and rotation angle measurements
○ c. a or b

18. Damping is a very important consideration when designing control systems. Which of the following damping ratios is the most desirable?
○ a. DR < 1
○ b. DR = 1
○ c. DR > 1

19. Which of the following control methods also requires precession and nutation control?
○ a. body spin
○ b. gravity gradient
○ c. magnetic
○ d. mass expulsion
○ e. momentum transfer

20. Which of the following control methods would NOT be effective at geosynchronous altitude?
○ a. body spin and mass expulsion
○ b. body spin and momentum transfer
○ c. gravity gradient and magnetic
○ d. momentum transfer and mass expulsion

21. Which of the following control methods is/are passive - using no fuel or electrical power to function?
○ a. magnetic
○ b. mass expulsion
○ c. momentum transfer
○ d. body spin and gravity gradient
○ e. a, b, and c

22. Which of the following control method(s) employ active closed loop control using sensor feedback?
○ a. magnetic
○ b. mass expulsion
○ c. momentum transfer
○ d. body spin and gravity gradient
○ e. a, b, and c

23. Using the momentum bias control method, for spin (gyroscopic) stabilization to be effective, the following must be true: __________________.
○ a. applied thruster torque expelled from the nozzle must be high
○ b. applied magnetic moment generated within the spacecraft must be high
○ c. $I(1)<I(2)<I(3)$, where I(x) represents the scalars of the principal moments of inertia
○ d. $I(1)>I(2)>I(3)$, where I(x) represents the scalars of the principal moments of inertia
○ e. angular momentum of the wheel must be much greater than (>>) the product of the spacecraft moment of inertia and the spacecraft angular velocity

24. Of the 23 early flight anomalies identified; how many were NOT caused by the natural space environment?

- a. 3
- b. 11
- c. 14
- d. 21

25. Which of the following caused Apollo 13's sudden loss of attitude control?

- a. oxygen venting of gas into space; acting as uncontrolled gravity gradient
- b. oxygen venting of gas into space; acting as uncontrolled momentum transfer
- c. oxygen venting of gas into space; acting as uncontrolled magnetic
- d. oxygen venting of gas into space; acting as uncontrolled mass expulsion
- e. oxygen venting of gas into space; acting as uncontrolled momentum bias