Formulas:

$$\Theta = \frac{s}{r}$$

- angle Θ is in radians, s is the distance along the arc and r is the radius of the arc.

$$\omega = \frac{d\Theta}{dt}$$

- ω is angular speed

$$\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}$$

- α is angular acceleration

$$S = \theta r$$

- S is the linear distance along an arc, Θ is the angle in radians, and r is the radius of the arc.

$$v = \frac{ds}{dt} = r\frac{d\theta}{dt}, or\ v = r\omega$$

- v is linear speed

$$a = \frac{dv}{dt} = \frac{d^2s}{dt^2} = r\frac{dw}{dt} = r\frac{d^2\theta}{dt^2}, or\ a = r\alpha$$

- a is linear acceleration

$$v_x = \frac{dx}{dt} = r\omega \sin\theta$$

- v_x is the velocity or speed of the x or horizontal component

$$v_y = \frac{dy}{dt} = r\omega \cos\theta$$

- v_y is the velocity or speed of the y or vertical component

Trig Functions Handout, *CALCULUS FOR ELECTRONICS* Ch 16 (1-3), Timothy Leishman

16.1

1. In a directional broadcast antenna, tower 2 is located 212 feet from tower 1, in a direction 38° north of east. How far to the north of tower 1 is tower 2 situated?

2. A target-practice object is observed on a radar screen at an airline distance of 18,000 feet and at an elevation angle of 72°. If the object were shot down, at what horizontal distance from the observer would the wreckage fall, assuming a vertical fall?

3. A radar screen shows an object 70 miles from the observer at an angle of 50° east of north. How far to the east of the observer is the object?

4. A broadcast antenna is 100 ft tall and it is recommended that the guy wires to the top be anchored into the ground at an elevation angle to the horizon of 50°. Find (a) the length of each guy wire and (b) how far the anchor points are from the antenna base?

5. A microphone diaphragm intercepts 6.75×10^{-9} watts of acoustic power when turned broadside to a sound source. What will be the (theoretical) intercept power if the diaphragm is turned at an angle of 55° to the source?

6. Light radiation having a plane wavefront strike a photosensitive surface at an angle of 30°. If the surface were turned to face the light directly, by what factor would the amount of received light energy be increased?

7. A “Curtain” receiving antenna is broadside to a distant transmitter. If it is now turned through an angle of 21°, by what factor will the radiation power impinging upon the curtain be reduces?

8. A radar screen shows an object 40° east of north. A second radar screen located 100 miles directly east of the first screen locates the same object at 55° west of north at a distance of 76.9 miles. How far to the east of the first screen is the object?

16-2

- 360° = 2π radians
- 360° = 1 revolution
- 2π radians = 1 revolution

9. How many radians correspond to each of the following angles?

a. 180°

b. 90°

c. 45°

d. 60°

e. 30°

f. 15°

g. 20°

h. 54°

10. How many degrees correspond to each of the following angles expressed in radians?

a. $\frac{\pi}{4}$

b. $\frac{3\pi}{2}$

c. $\frac{\pi}{9}$

d. $\frac{2\pi}{3}$

e. $\frac{5\pi}{3}$

f. $\frac{\pi}{10}$

g. $\frac{4\pi}{3}$

h. $\frac{3\pi}{4}$

11. An Instrument pointer moves through an arc of 270°. To how many radians is this equivalent?

12. The radiation pattern of an antenna has a minimum value in a direction 24° off the antenna axis, express this angle in radians.

13. An armature turns at 1,800 revolutions per minute. To what value ω, in radians per second, does this correspond?

14. The coil of an instrument rotates at a rate of 0.005 radian per millisecond. Express this angular speed in degrees per second.

15. A motor accelerates at a rate of 600 revolutions per minute per second. To how many radians per second squared is this equal?

16. An instrument pointer is 2.1 inches long. The tip of the pointer moves over a scale 2.4 inches long. What angle does this describe in radians?

17. An alternator has a rotating field which is 32 inches in diameter. When the field is turned at 120 revolutions per minute, what is the linear speed of a point on its circumference?

18. If the field assembly in the question 17 is accelerated at 12 revolutions/min/sec, what linear acceleration is applied to a point on its circumference?

19. If the field assembly in question 17 turns in a counter clockwise direction, (a) what is the upward component of the velocity at a point P on its circumference when P is at an angle of 45° above the horizon? (b) what is the horizontal component of the velocity at the same point?

20. An airplane propeller has a radius of 3 feet to the blade tip. It is desired to keep the tip velocity below the speed of sound (769.5 miles per hour). What number of revolutions per minute would correspond to this limit?

21. It can be shown that, when an armature of radius r rotates at ω radians per second, a point on its circumference is given a constant normal acceleration toward the center equal to $a_n = r\omega^2$. If an armature 0.3 meters in diameter is rotated at 2,000 revolutions per minute, (a.) to what normal acceleration will a conductor on the surface be subjected? Using $f = ma$, (b.) what centrifugal force in newtons will be applied to a conductor of mass 0.04Kg located at the circumference?

22. When power is applied to a motor, the shaft speed during initial power-up corresponds to $10t + 4t^2$ revolutions per second. (a.) Write an equation for the angular speed ω, in radians per second of the shaft. (b.) Find an equation for the angular acceleration α of the shaft at any time. (c.) Find an equation for the angle θ, in radians, of the shaft position at any time. (d.) Find the angular position θ, in degrees, at $(a.)\ t = 0.1\,\text{sec}$ & $(b.)\ t = 0.2sec$. (assume $\theta = 0\ at\ t = 0$).

$$\frac{d}{dx}\sin u = \cos u \frac{du}{dx} \qquad \frac{d}{dx}\cos u = -\sin u \frac{du}{dx}$$

Perform the derivative for the following functions.

23. $y = \sin 2x$
24. $y = 3\sin x$
25. $y = 12\sin 14t$
26. $y = 10\sin 10t^{\frac{1}{2}}$
27. $y = \sin t^2$
28. $y = 2\cos 3t^3$
29. $y = 500\cos(t^2 - t)^{\frac{1}{2}}$
30. $y = 10t^3 + \cos t$
31. $y = sin^2 t$
32. $y = -cos^2 t^{-1}$
33. $y = 2sin^2 t^2$

34. Let the primary current in a transformer be $i_1 = I_{Max}\sin\omega t$, Where I_{Max} is the crest value of the current. Write a formula for the induced secondary emf v_2.

35. A voltage $v = 2{,}000\sin 500t$ is impressed across a 20uF capacitor. Find a formula for the resulting current.