Maharashtra Engineering Services Combined (Pre) Exam 2018
Questions with Detailed Solutions

11. Identify the correct sentences.

a. She got up when the alarm clock went off.

b. Erika had dropped her bag while she was getting into her car.

c. It was the first time I'd talked to Ella outside the office.

d. She will be taking up her place at University in October.

(1) a and c (2) b and d

(3) a, c and d (4) b, c and d

11. Ans: (3)

Explanation: a, c and d are grammatically correct. Option b is incorrect because of part perfect (one after other). They are simultaneous actions and should be in simple part (Erika dropped her bag) and past continuous (while she was getting into her car).

12. Match the following pairs of antonyms:

List-I	**List-II**
a. Colleague	I. Indolence
b. Promptness	II. Honesty
c. Duplicity	III. Benevolence
d. Objection	IV. Opponent

Codes:	**a**	**b**	**c**	**d**
(1)	II	III	IV	I
(2)	III	II	IV	I
(3)	I	IV	III	II
(4)	IV	I	II	III

12. Ans: (4)

Explanation:

a. Colleague means a person who works with you: a fellow worker. Its antonym is opponent means a person, a team, group, etc; that is competing against another in a contest.

b. Promptness means being ready and quick to act as occasion demands. Its antonym is indolence means inclination to laziness.

c. Duplicity means dishonest behaviour that is meant to trick someone. It is antonym is honesty means the quality of being four and truthful.

d. Objection means a reason for disagreeing with or opposing something. Its antonym is benevolence means disposition to good so the right pair is '4'

13. Choose the appropriate pair to fill in the blanks in both the given sentences.

a. Measles is highly _____.

b. England is the only country _____ to Wales.

(1) contagious, contagious (2) contiguous, contagious

(3) contagious, contiguous (4) contiguous, contiguous

13. Ans: (3)

Explanation: The befitting pour is '3'

Contagious means able to be passed from one person or animal to another by touching. Contiguous means used to describe things that touch each other or are immediately next to each other.

14. Complete the sentence with who, which, whom or what.

_____ of them broke the window?

(1) Who (2) Whom

(3) What (4) Which

14. Ans: (4)

Explanation: Which means what one or ones of a group: What particular one or ones.

15. Choose the alternative containing the correct sequence of words to fill in the blanks in the given sentences.

a. _____ was a big audience for the concert the night.

b. _____ is no answer.

c. _____ is a car outside.

(1) There, It, It (2) There, There, There

(3) There, There, It (4) It, It, It

15. Ans: (2)

Explanation: There as an adverb means in that place; in that location; to or into that place; at that location; to or into that place; at that point in a process; activity, story etc

Read the following passage carefully and answer the questions from 16 to 20.

If from a hilltop you could watch a panther stalking his prey, he would offer a most interesting spectacle. You would see him taking advantage of every bush, of every tree trunk and of every stone behind which to take cover. He can flatten himself to the ground in an amazing fashion. His colouration renders him invisible, unless you have the keenest eyesight. I once watched one through a pair of binoculars and was amazed at the really wonderful sense of woodcraft the panther had. Then comes the final rush. In a couple of bounds and with lightning speed, he reaches his prey.

16. Give the meaning of the idiom 'to take advantage of'.

(1) Profit selfishly by exploiting (2) Put to good use

(3) None of these (4) All of these

16. Ans: (4)

Explanation: The idion to take advantage of something to make use of something to make use of somebody or something in a way that is unfair or dishonest (synonym is exploit) Both 1 and 2 have these meanings.

17. What is the word for the phenomena 'his colouration renders him invisible'?

(1) Concentration (2) Commouflagne

(3) Configuration (4) Camouflage

17. Ans: (4)

Explanation: Camouflage means away of hiding something (such as military equipment) by painting it or covering it with leaves or branches to make it harder to see. So his colouration renders him invisible has this meaning.

(or)

Something (such as colour or shape) that protects an animal from attack by making the animal difficult to see in the area around it.

18. What is the panther doing in the story?

(1) Hiding (2) Stalking

(3) Rushing (4) Flattening

18. Ans: (2)

Explanation: The first line of the paragraph says… watch a panther stalking his prey means panther was stalking which means to follow (an animal or person that you are hunting or trying to capture) by moving slowly and quietly.

19. With the help of which instrument did the writer watch the panther?

(1) Spectacle (2) Binoculars

(3) Tree trunk (4) None of these

19. Ans: (2)

Explanation: In the sixth line the author says he once watched through a pair of binoculars

20. How was the panther stalking his prey?

(1) Hiding behind the tree trunk (2) Taking advantage of every bush

(3) Flatten himself to the ground (4) All of these

20. Ans: (4)

Explanation: Second and third line refer to option 1, 2 and 3

21. Which of the following district/districts does not have 100% geographical areas in the Godavari river basin?

(1) Aurangabad and Beed (2) Latur

(3) Jalna and Parbhani (4) Hingoli and Nanded

21. Ans:(2)

Explanation: Godavari flows through Nashik, Ahmadnagar, Aurangabad, Jalna, Parbhani, Hingoli, Nanded and Beed districts of Maharashtra.

Latur district does not come under Godavari river basin. This District comes under sub-Basin of Godavari River.

Manjara/Manjeera (Tributary of river Godavari) is the main river in Latur district along with its tributaries Terna, Tawarja and Gharni.

22. According to 2011 Census, _____ and _____ districts have less than 15% of their population living in urban areas.

(1) Gadchiroli and Sindhudurg (2) Gadchiroli and Gondia

(2) Gondia and Sindhudurg (4) Gondia and Washim

22. Ans: (1)

Explanation:

Gadchiroli: As per Census 2011 out of total population, 11% people lives in Urban areas while 89% lives in the Rural areas.

Gondia: As per Census 2011 out of total population, 17.1% people lives in Urban areas while 82.9% lives in the Rural areas.

Sindhudurg: As per Census 2011 out of total population, 12.6% people lives in Urban areas while 87.4% lives in the Rural areas.

Washim: As per Census 2011 out of total population, 17.7% people lives in Urban areas while 82.3% lives in the Rural areas.

23. Consider the following statements:

a. The Government of India announced a National Agriculture Policy on July 28, 2000.

b. The Government of India announced a New Industrial Policy on July 24, 1991.

c. The Government of India announced the New Computer Policy in 1984.

Which of the statement/s given above is/are incorrect?

(1) a and b (2) b and c

(3) Only c (4) None of these

23. Ans: (4)

24. Consider the following statements:

a. The National Planning Committee was set up in October 1945 under the Chairmanship of Jawaharlal Nehru.

b. Planning Commission was set up in March 1950.

c. The National Development Council was set up in August 1952.

Which of the statements given above are correct?

(1) a and b (2) b and c

(3) a and c (4) All of the above

24. Ans: (2)

Explanation: 1938 was the year that witnessed the first attempt to develop a national plan for India when National Planning Committee was set up. This committee was set up by **Subhash Chandra Bose** and chaired by **Jawaharlal Nehru**.

25. Consider the following statements:

a. Indian Banks need to lend 40 percent to the priority sector every year.

b. Foreign Banks have to fulfil only 32 percent priority sector lending target.

c. All Indian Banks do not have to follow the compulsory target of priority sector lending.

Which of the statement/s given above is/are correct?

(1) a and b (2) Only c

(3) b and c (4) None of these

25. Ans: (1)

Explanation: All Indian Banks must have to follow the priority sector lending guidelines issued by RBI.

26. Liquidity Adjustment facility by RBI allows

a. RBI to manage market liquidity on daily basis.

b. Transmit interest rate signals to the market.

Which of the statements given above is/are correct?

(1) Only a (2) Only b

(3) Both a and b (4) None of the above

26. Ans: (3)

27. India's Human Development Index Number was _____ in the year 2011.

(1) 134 (2) 120

(3) 140 (4) 130

27. Ans: (1)

Explanation: A United Nations study has ranked India at 134 out of 187 countries in terms of Human Development Index.

28. India's First Women's Bank was established in which year's budget?

(1) 2010-11 (2) 2012-13

(3) 2013-14 (4) 2015-16

28. Ans: (3)

Explanation: In Budget 2013-14, the Finance Minister had announced setting up of all-women bank (Bharatiya Mahila Bank) with an initial capital of Rs 1,000 crore.

29. If the Panchayat Samity is immersed, then how long will be the tenure of the newly elected Panchayat Samiti?

(1) 6 months (2) $2\frac{1}{2}$ years (3) One year

(4) As much as the remaining tenure of the immersed Panchayat Samiti

29. Ans: (4)

Explanation: Under Article 243 E(4), A Panchayat constituted upon the dissolution of a Panchayat before the expiration of its duration shall continue only for the remainder of the period for which the dissolved Panchayat would have continued.

30. Match the pairs:

List-I	**List-II**
a. Article-156	I. Executive authority of Governor
b. Article-154	II. Tenure of Governor
c. Article-153	III. Discretionary power of Governor
d. Article-155	IV. Office of Governor
	V. Appointment of Governor

Codes:

	a	**b**	**c**	**d**
(1)	III	II	V	I
(2)	II	I	IV	V
(3)	I	II	III	IV
(4)	III	I	IV	II

30. Ans: (2)

Explanation:

Article 153: Governors of States There shall be Governor for each State

Article 154. Executive power of State

Article 155. Appointment of Governor the Governor of a State shall be appointed by the President

Article 156. Term/Tenure of office of Governor

31. For what reason were the 'Run for Laadli Half Marathon Competitions organized?

(1) To cause awareness amongst the people about women protection

(2) To cause awareness about children and their better future

(3) To cause awareness about little girls for their better future

(4) To cause love for physically handicapped people

31. Ans: (1)

Explanation: In association with the Laadli foundation, the Delhi police organised 'Run for Laadli', that aimed at spreading awareness about gender equality and stop crimes against women in the capital.

32. Which of the following became the first State in India to pass a law to protect journalists from attack?
(1) Goa (2) Haryana
(3) Maharashtra (4) Madhya Pradesh

32. Ans: (3)

33. Which border of India will be sealed by 2018 as announced by the Home Minister of India?
(1) India-Pakistan (2) India-Nepal
(3) India-Bangladesh (4) India-Sri Lanka

33. Ans: (1)

34. According to year 2017 report of "The International Institute of Gutmaker' and 'India Institute of Population Sciences', how many women died because of abortion in every year in India?
(1) 10 Lakh (2) 20 Lakh
(3) 25 Lakh (4) 30 Lakh

34. Ans: (2)

35. Union Minister of Human Resource Development Shri Prakash Javadekar has launched Portal and mobile app for RUSA. What is the meaning of RUSA?
(1) Rajkiya Uchch Shikshan Abhiyan
(2) Rashtriya Uchchatar Shiksha Abhiyan
(3) Rashtriya Uchchatar Shikshan Andolan
(4) Regional Uchch Shiksha Abhiyan

35. Ans: (2)

Explanation: Rashtriya Uchchatar Shiksha Abhiyan (RUSA) is a Centrally Sponsored Scheme (CSS), launched in 2013 aims at providing strategic funding to eligible state higher educational institutions.

36. GST was introduced as which Amendment Act?

(1) 101 (2) 108

(3) 120 (4) 106

36. Ans: (1)

Explanation: GST ACT: 122 Amendment Bill and 101 Amendment Act

37. Which of the following is most harmful for ozone depletion?

(1) Chlorine and nitrogen (2) Carbon monoxide

(3) Carbon dioxide (4) Sulphur dioxide

37. Ans: (1)

Explanation: Ozone depletion: Reduction in the concentration of ozone in the ozone layer.

As per Dutch chemist Paul Crutzen, nitrogen oxide catalytic cycle affects ozone levels.

And also the global decrease in stratospheric ozone is well correlated with rising levels of chlorine and bromine in the stratosphere.

38. Which movement in a State of India was led under the leadership of Sundarlal Bahuguna?

(1) Chipko Revolution-Tamil Nadu

(2) Silent Valley Revolution-Kerala

(3) Narmada Bachao Andoan-Madhya Pradesh

(4) Appiko Revolution-Karnataka

38. Ans: (4)

Explanation: On Sep.8, 1983, Pandurang Hegde, the fiery activist, started the Appiko (to hug) movement. He derived inspiration from Sunderlal Bahugana's Chipko movement.

39. Who was selected as the President of Constitution Committee of India on 11th December 1946?

(1) Dr. Rajendra Pradesh (2) Dr. Babasaheb Ambedkar

(3) Dr. Sachidanand Sinha (4) Purushottam Das Tandon

39. Ans: (1)

Explanation: Dr. Rajendra Prasad is the president of Constituent Assembly in 1946.

40. Arrange the following institutions in their chronological order:

a. Chhatrapati Shivaji College, Satara

b. Maharaja Sayajirao High School, Satara

c. Silver Jubilee Rural Training College, Satara

d. Chhatrapati Shahu Boarding House, Satara

(1) a, b, c, d (2) d, c, b, a

(3) d, b, c, a (4) d, a, c, b

40. Ans: (2)

Explanation:

- **Chhatrapati Shivaji College** is the first **college** of the Rayat Shikshan Sanstha, established in 1947 by the founder of the Sanstha, Karmaveer Bhaurao Patil.
- Maharaja Sayajirao High School, Satara - Founder Dr. Karmaveer Bhaurao Patil, **Established**-1940.
- Karmaveer Bhaurao Paygonda Patil started 'Silver Jubilee Rural Training College' at Satara in 1935.
- Chhatrapati Shahu Boarding House, Satara - 1872

41. When a body is in equilibrium under the action of three forces, then each force is proportional to the _____angle between the other two forces.

(1) cos (2) sin (3) tan (4) cot

41. Ans: (2)

Sol: By Lami's theorem when a body is in equilibrium under the action of three forces, then each force is proportional to sine of angle between the other two forces.

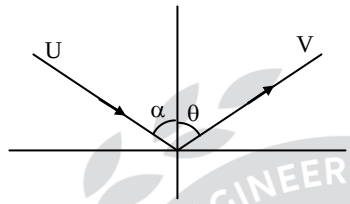
42. If u and v are initial and final velocities of a body having an indirect impact on a fixed plane and α and θ are angles with line of impact made by initial and final velocities and if e is coefficient of restitution, then Newton's law of collision which holds good for this impact is

(1) $v\cos\theta = eu\cos\alpha$ (2) $u\cos\theta = ev\cos\alpha$

(3) $v\sin\theta = eu\sin\alpha$ (4) $u\sin\theta = eu\sin\alpha$

42. Ans: (1)

Sol:



$$e = \frac{\text{velocity of separation}}{\text{velocity of approach}}$$

$$e = \frac{V\cos\theta}{U\cos\alpha}$$

$V\cos\theta = e \times U\cos\alpha$

43. Complete determination of resultant force of non-concurrent forces is

a. determination of magnitude

b. determination of direction

c. determination of point on its line of action

(1) only a and b (2) Only a and c

(3) a, b and c (4) None of these

43. Ans: (3)

Sol: A force is completely characterized by

- Its magnitude
- Its direction
- Its point of application

44. D- Alembert's principle states that if a rigid body is acted upon by system of forces, this system of forces may be reduced to a single resultant force whose_____ may be found out by the method of graphic statics.

(1) magnitude (2) direction

(3) line of action (4) magnitude, direction and line of action

44. Ans: (4)

Sol: If a rigid body is acted upon by system of forces, this system of forces may be reduced to a single resultant whose magnitude, direction and line of action may be found out by the method of graphic statics.

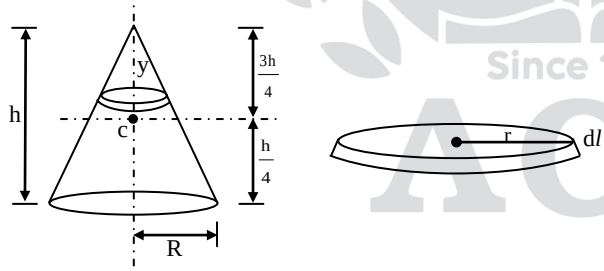
45. The centre of gravity of right circular cone of height 'h' lies at a distance___from vertex along the axis of rotation.

(1) $\frac{h}{4}$ (2) $\frac{3h}{4}$

(3) $\frac{h}{3}$ (4) $\frac{2h}{3}$

45. Ans: (2)

Sol:



Where c = centre of gravity

$$dm = \frac{m}{\frac{1}{3}\pi R^2 \ell}\pi r^2 d\ell = \frac{3Mr^2\, d\ell}{R^2\, \ell}$$

Now, $r = y\tan\theta$ and $\ell = \frac{dy}{\cos\theta}$

$$\bar{y} = \frac{\int_o^h \frac{3Mr^2 d\ell}{R^2\ell} \times y}{\int dm}$$

$$= \frac{\frac{3M}{R^2\ell}\int (y \times \tan\theta)^2 \frac{dy}{\cos\theta} y}{M}$$

$$\bar{y} = \frac{3}{R^2\ell}\frac{\tan^2\theta}{\cos\theta}\int_o^h y^3 dy$$

$$= \frac{3h^4}{4R^2\ell}\frac{\tan^2\theta}{\cos\theta} = \frac{3h}{4}$$

[$\because$ $h \tan\theta = R$.

$\frac{h}{\cos\theta} = \ell$]

46. In order to study the dynamic response of a body, it is important to locate the body's

(1) colour (2) emissivity

(3) centre of mass (4) None of these

46. Ans: (3)

Sol: To study dynamic response of a body, it is important to locate body's centre of mass.

47. The component of the resultant linear impulse along any direction is equal to

(1) zero

(2) change in the component of momentum in that direction

(3) change in the component of momentum in opposite direction.

(4) None of these

47. Ans: (2)

Sol: Linear impulse = $\vec{P}$ = change in momentum in that direction.

48. In technique used to reduce a coplanar or parallel force system to a single resultant force, the resultant force is equal to

(1) sum of all forces in the system

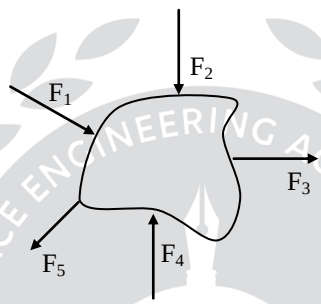
(2) sum of all positive forces in the system

(3) sum of all negative forces in the system

(4) None of these

48. Ans: (1)

Sol: Resultant force is equal to sum of all the forces in the system.



$\vec{R} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 + \vec{F}_5$

49. A projectile is projected from a point on ground with velocity of projection 'u' and angle of projection 'α'. How much maximum height can the projectile reach?

(1) $h = \frac{u \sin \alpha}{2g}$ (2) $h = \frac{u^2 \sin^2 \alpha}{2g}$

(3) $h = \frac{u^2 \sin \alpha}{2g}$ (4) $h = \frac{u \sin^2 \alpha}{2g}$

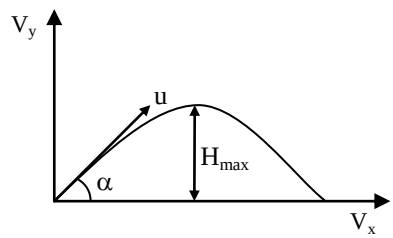
49. Ans: (2)

Sol: $v_y = u \sin \alpha$

At maximum hight, $v_y = 0$

$u \sin\alpha = gt$

$t = \frac{u \sin \alpha}{g}$



$H = \frac{1}{2} g t^2 = \frac{1}{2} \times g \times \left(\frac{u \sin \alpha}{g} \right)^2 = \frac{u^2 \sin^2 \alpha}{2g}$

50. A concurrent force system is one in which the lines of action of all the forces intersect at a common point O, then the force system produces

(1) no moment about this point (2) moment about this point

(3) Both (1) and (2) are produced (4) None of these

50. Ans: (1)

Sol: As forces intersect at common point no moment is produced.

$$\vec{M} = \vec{r} \times \vec{F}$$

Where $\vec{r}$ is the position vector from the point of intersection.

If $\vec{r} = 0$ then $\vec{M} = 0$

51. Parallelogram law of forces states that if two forces acting simultaneously at a point be represented in magnitude and direction by two adjacent sides of parallelogram, their resultant may be represented in magnitude and direction by

(1) longer side of the other two sides

(2) shorter side of the other two sides

(3) diagonal of the parallelogram which passes through their points of intersection

(4) diagonal of the parallelogram which does not pass through their point of intersection.

51. Ans: (3)

Sol: If the two forces acting simultaneously at a point be represented in magnitude and direction by two adjacent sides a parallelogram, their resultant may be represented in magnitude and direction by diagonal of the parallelogram which passes through their points of intersection.

52. In friction, friction force F is termed as ____ when sliding occurs at the contacting surface.

(1) kinetic frictional force (2) kinematic frictional force

(3) static frictional force (4) None of these

52. Ans: (1)

Sol: Friction force is called static friction force when body no sliding occurs at contacting surface. Friction force is called kinetic friction when sliding occurs at contacting surfaces.

53. The negative ratio of the relative velocities of two colliding bodies after and before collision is called as

(1) Coefficient of Restitution (2) Coefficient of Friction

(3) Elastic Collision (4) Inelastic Collision

53. Ans: (1)

Sol: Coefficient of restitution = $\frac{\text{Relative velocity after collission}}{\text{Relative velocity before collission}}$

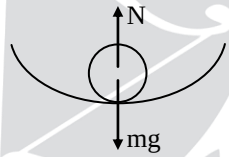
54. An automobile of mass 1000 kg moving at a velocity 54 kmph, moves along a sag. This sag is a part of a circle of 15 m radius. What is the reaction between the automobile and road while travelling at the lowest part of sag?

(1) 24.8 kN (2) 248 kN

(3) 2480 kN (4) 24800 kN

54. Ans: (1)

Sol:



$$N - mg = \frac{mV^2}{R}$$

$$N = \frac{mV^2}{R} + mg = \frac{1000 \times 15^2}{15} + 9.81 \times 1000 = 24.3 \text{ kN}$$

55. The required minimum compressive strength of building bricks as recommended by IS 1077-1957 and 1970 is

(1) 140 kg/cm^2 (2) 105 kg/cm^2

(3) 70 kg/cm^2 (4) 35 kg/cm^2

55. Ans: (4)

Sol: Compressive strength of bricks $= \frac{\text{Maximum load at failure (N)}}{\text{Avg. area of bed face(mm}^2\text{)}}$

The minimum compressive strength of common building bricks is 35 kg/sq.cm

56. The minimum compressive strength for rapid hardening Portland cement after 72 hours should be

(1) 18 N/mm^2 (2) 28 N/mm^2

(3) 24 N/mm^2 (4) None of these

56. Ans: (2)

Sol: The average compressive strength for rapid hardening cement after 72 hours ±1 hour not less than 26.97 N/mm^2 (27.514/cm^2) so, the best suitable option is (2).

57. The maximum settlement for the isolated foundation on clayey soils should be limited to

(1) 65 mm (2) 25 mm

(3) 40 mm (4) 100 mm

57. Ans: (1)

Sol: As per guidelines, maximum allowable settlement for isolated foundation on clayey soil is 65 mm

58. As per IS 1893-2002, Zone I shown in 'Seismic Zones of India' map corresponds to

(1) maximum intensity I (2) Maximum intensity III

(3) Maximum intensity V (4) Maximum intensity VII

58. Ans: (3)

Sol:

Seismic zone	**Probable maximum Intensities (MMI Scale)**
0	Below V
I	V
II	VI
III	VII
IV	VIII
V	IX
VI	X and above

59. Which of the following is a disadvantage of framed structures?

(1) Flexibility in planning (2) Speed of construction

(3) Economy (4) Span length

59. Ans: (4)

Sol: Demerits of Framed Structure:

In frames structure, span length are restricted to 40ft when normal reinforced concrete. Other wise spans larger than that can cause lateral deflections.

60. What is fineness modulus of course send?

(1) 2.9 – 3.2 (2) 2.4 – 3.0

(3) 1.5 – 2.1 (4) 1.8 – 2.4

60. Ans: (1)

Sol:

Type of sand	FM Range
Fine sand	2.2 – 2.6
Medium sand	2.6 – 2.9
Coarse sand	2.9 – 3.2

61. A total station is a combination of

(1) Theodolite and EDM (2) Electronic theodolite and EDM

(3) Compass and EDM (4) Electronic compass and EDM

61. Ans: (3)

Sol: A total station is an electronic/optical instrument used in modern surveying. The total station is an electronic theodilite (transist) integrated with an electronic distance meter (EDM).

62. Which of the following Electronic Distance Measurements is useful in major construction where alignment is to be done precisely and quickly?

(1) Optical theodolite (2) Digitial theodolit

(3) Laser theodolite (4) Vernier theodolite

62. Ans: (2)

Sol: Laser theodilites, have all the functions of electronic theodolite with facility of more accurately bisecting the target.

Among the options, best suitable option is (3)

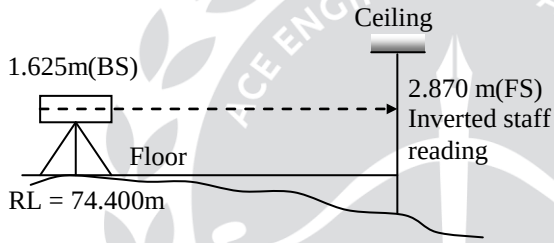
63. Reduced Level (R.L.) of the floor at building is 74.400 m, staff reading on the floor is 1.625 m and staff reading when it is held inverted with bottom touchng the ceiling of a hall is 2.870 m, then the height of the ceiling above the floor is

(1) 3.593 m (2) 3.953 m

(3) 4.594 m (4) 4.495 m

63. Ans: (4)

Sol:



Ht.of ceiling = 1.625 + 2.870 = 4.495

64. A lamp at the top of a lighthouse is visible just above the horizon from a station at sea level. The distance of the lamp from the station is 30 km. The height of the lighthouse is

(1) 60.57 m (2) 30.0 m

(3) 20.61 m (4) 54.0 m

64. Ans: (1)

Sol: $h = 0.06735 \times (30)^2$

$= 60.61$

Best suitable option is (1)

65. A device/devices which transfers heat from low temperature region to high temperature is

(1) Only refrigerator (2) Only heat pump

(3) Both refrigerator and heat pump (4) None of these

65. Ans: (3)

Sol: Heat pump and refrigerator, both transmit thermal energy by absorbing heat from a cold space and releasing it to a warmer space.

66. _____ possesses lowest thermal conductivity among the following materials:

(1) Sawdust (2) Ash

(3) Glass wool (4) Freon

66. Ans: (3)

Sol: Glass wool has the lowest thermal conductivity among them.

Glass wool (k) ≅ 0.03 to 0.04 W/mK

Saw dust (k) ≅ 0.07 to 0.08 W/mK

Ash (k) ≅ 0.1 to 0.15 W/mK

Freon (k) ≅ 0.07 to 0.08 W/mK

67. _____ is not the assumption of Fourier's equation of heat conduction.

(1) Constant temperature difference (2) Uniform area of cross-section

(3) Steady heat flow (4) Homogeneous substance

67. Ans: (2)

Sol: Uniform cross-sectional area is not the assumption of Fourier's law of heat conduction. Cross-section area may or may not be uniform.

68. If the designation of a deep-groove ball bearing is 6014, then bore diameter is _____ mm

(1) 60 (2) 70

(3) 84 (4) 74

68. Ans: (2)

Sol: $6\,0\,\underset{\downarrow}{14}$

Bore diameter = 14 × 5 = 70 mm

69. If 'm' is the mass per unit length of belt, "T" is maximum allowable belt tension and 'T_c' is centrifugal tension, for maximum power transmission, the velocity of the belt is

a. $\sqrt{\frac{T}{3m}}$ b. $\sqrt{\frac{T_c}{m}}$ c. $\sqrt{\frac{3T}{m}}$ d. $\sqrt{\frac{m}{T_c}}$

Which of the given above is /are correct?

(1) Only c (2) Only d

(3) a and b (4) c and d

69. Ans: (3)

Sol: Condition for maximum power transmission : $T = 3\,T_c$

The belt velocity is given by, $v = \sqrt{\frac{T}{3m}} = \sqrt{\frac{3T_c}{3m}} = \sqrt{\frac{T_c}{m}}$

70. Which gears are used to transmit heavy load, high speed at low noise level between parallel shaft?

(1) Spur gears (2) Helical gears

(3) Bevel gears (4) Worm gears

70. Ans: (2)

Sol: In Helical gears, the contact between the two meshing teeth begins with a point and gradually extends along the tooth, resulting in quiet operations.

71. Which is inversion of four-bar mechanism?

(1) Coupling rod of locomotive (2) Whitworth quick return motion mechanism

(3) Elliptical trammel (4) Oldham's coupling

71. Ans: (1)

Sol:

- Coupling rod of locomotive → Four bar mechanism
- Whitworth quick return motion mechanism → single slider crank mechanism
- Elliptical trammel → Double slider crank mechanism
- Oldham's coupling → connecting two shafts for power transmission with accommodation of small angular and axial misalignment.

72. Which of the following material requires the largest shrinkage allowance, while making a pattern for casting?

(1) Malleable Iron (2) Plain Carbon Steel

(3) Lead (4) Brass

72. Ans: (3)

Sol: $\alpha_{iron} \simeq 12$ /°C

$\alpha_{steel} \simeq 13$ /°C

$\alpha_{lead} \simeq 29$ /°C

$\alpha_{brass} \simeq 19$ /°C

here, α = coefficient of thermal expansion.

Lead has more expansion / contraction during heating / cooling among all of the above.

73. ___ is widely used in tool steels because the tool will maintain its hardness even at red heat.

(1) Chromium (2) Nickel

(3) Tungesten (4) Vanadium

73. Ans: (3)

Sol: Red hardness is achieved by alloying steel with tungsten.

74. Maximum fluctuation of energy of flywheel is defined as

(1) sum of maximum and minimum energy

(2) ratio of maximum and minimum energy

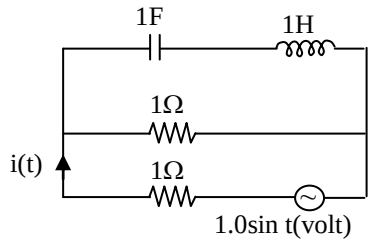
(3) ratio of minimum and maximum energy

(4) difference between maximum and minimum energy

74. Ans: (4)

Sol: The maximum fluctuation of energy is defined as the difference between the maximum kinetic energy and minimum kinetic energy in the cycle.

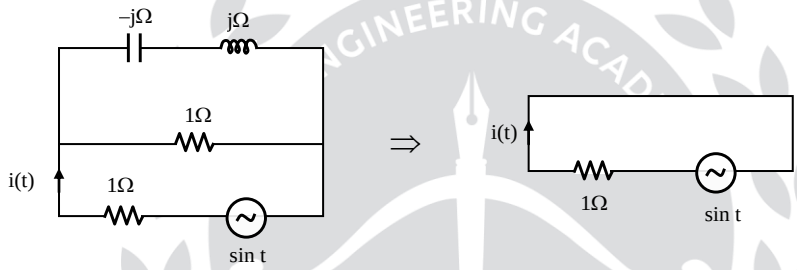
75. The RMS value of the current (t) in the circuit shown below is



(1) $\frac{1}{2}$A (2) $\frac{1}{\sqrt{2}}$A (3) 1A (4) $\sqrt{2}$ A

75. Ans: (2)

Sol: The given circuit can be drawn as



i(t) = sin t A

$i_{r.m.s} = \frac{1}{\sqrt{2}}$A

76. Three resistances of 3Ω each are connected in delta. The value of the resistance in the equivalent star is

(1) 27 Ω (2) 9 Ω

(3) 1.5 Ω (4) 1 Ω

76. Ans: (4)

Sol: $R_{star} = \frac{R_{\Delta}}{3} = \frac{3}{3} = 1\Omega$

77. The maximum power transferred to a load for a resistive. Thevenin's circuit and condition for which it occurs are

(1) $P_{max} = \frac{4V_T^2}{R_T}$ and $R_L = R_T$

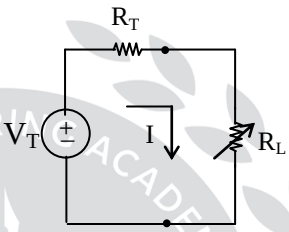
(2) $P_{max} = \frac{V_T^2}{4R_T}$ and $R_L = R_T$

(3) $P_{max} = \frac{2V_T^2}{R_T}$ and $R_L = R_T$

(4) $P_{max} = \frac{V_T^2}{2R_T}$ and $R_L = \frac{R_T}{2}$

77. Ans: (2)

Sol: $I = \frac{V_T}{R_T + R_L}$



$P = I^2 \cdot R_L$ watt $= V.I. = R_L I \,.\, I$

$P = \frac{V_T^2 \cdot R_L}{(R_T + R_L)^2}$ watt

For MPT $\Rightarrow \frac{dP}{dR_L} = 0$

$$\frac{dP}{dR_L} = \frac{V_T^2[(R_T + R_L)^2.1. - R_L.2(R_T + R_L)]}{\left[(R_T + R_L)^2\right]^2}$$

$$\Rightarrow V_T^2(R_T + R_L)[R_T + R_L - 2R_L] = 0$$

$\Rightarrow RT - RL = 0$

$\Rightarrow R_L = R_S\ \Omega$

$$P_{max} = P_{R_L = R_T} = \frac{V_T^2}{4R_L} watt = \frac{V_T^2}{4R_T} watt$$

78. An electric heater is rated as 1 kW, 250 V. Calculate the current taken by it if it is connected to 200 V supply.

(1) 4.5 A (2) 3.2 A

(3) 5 A (4) 3 A

78. Ans: (2)

Sol: $\frac{V^2}{R}$

$\Rightarrow R = \frac{V^2}{P} = \frac{250 \times 250}{1000} \Rightarrow \frac{250}{4}\Omega$

$I = \frac{V}{R}$

$= \frac{200 \times 4}{250} = 3.2$ A

79. For a series R – C circuit V_R is (the voltage across the Resistance, R and) measure to be 8V and V_C is (the voltage across the capacitance, C and) measured as 6V. The ac source voltage will be

(1) 14 V (2) 8 V

(3) 10 V (4) 12 V

79. Ans: (3)

Sol: The ac source voltage is $= \sqrt{V_R^2 + V_c^2}$

$= \sqrt{8^2 + 6^2} = 10$V

80. The open circuit test in a transformer is performed with

(1) rated transformer voltage (2) rated transformer current

(3) direct current (4) high frequency supply

80. Ans: (1)

Sol: Open circuit test is conducted at rated voltage and rated frequency.

Short circuit test is conducted at rated current and at rated frequency.

81. RMS value of current given by

$i = 10 + 5\cos(628\,t + 30°)$ is

(1) 3.53 A (2) 5 A

(3) 10.6 A (4) 15.6 A

81. Ans: (3)

Sol: $I_{rms} = \sqrt{10^2 + \left(\frac{5}{\sqrt{2}}\right)^2} = \sqrt{100 + \frac{25}{2}} = \frac{15}{\sqrt{2}} = 10.6\ A$

82. A balanced star connected load has a line voltage V_L, line current I_L and impedance per phase Z. When it is connected in equivalent delta connected system for same line values of voltage and current as in case of star connected system, the per phase impedance will be

(1) ZΩ (2) $\sqrt{3}$ ZΩ

(3) 3 ZΩ (4) Not determined from given data

82. Ans: (3)

Sol: **Case:(i)** For star connected load, $Z/ph = \frac{V_{ph}}{I_{ph}} = \frac{\frac{V_L}{\sqrt{3}}}{I_L} = \frac{1}{\sqrt{3}}\left(\frac{V_L}{I_L}\right)$

$$\Rightarrow \frac{V_L}{I_L} = \sqrt{3}\ Z/ph$$

Case: (ii): In Δ-connection, $Z/ph = \frac{V_{ph}}{I_{ph}} = \frac{V_L}{\frac{I_L}{\sqrt{3}}} \Rightarrow \sqrt{3}\left(\frac{V_L}{I_L}\right) = \sqrt{3}\left(\sqrt{3}Z\right) = 3Z$

83. In the equivalent circuit of a practical transformer, its magnetizing impedance is determined by

(1) Short circuit test

(2) Open circuit test

(3) Both short circuit and open circuit tests

(4) Other than above tests

83. Ans: (2)

Sol: Magnetizing impedance is determined from open circuit test.

84. A 3-phase load is balanced if all the three phases have the same

(1) impedance (2) power factor

(3) impedance and power factor (4) None of these

84. Ans: (3)

Sol: For balanced load, all the three phases have same impedance and power factor.

85. The length of the curve $y = \frac{2}{3}x^{3/2}$ between x = 0 and x = 1 is

(1) 0.27 (2) 0.67

(3) 1 (4) 1.22

85. Ans: (4)

Sol: The length of a curve y = f(x) between $x = x_1$ and $x = x_2$ is

$$\int_{x_1}^{x_2}\sqrt{1+\left(\frac{dy}{dx}\right)^2}\,dx$$

Here, $y = \frac{2}{3}x^{3/2}$

$$\frac{dy}{dx} = \sqrt{x}$$

Required length $= \int_0^1 \sqrt{1+x}\,dx$

$$= \frac{2}{3}\left[\left(1+x\right)^{\frac{3}{2}}\right]_0^1 dx$$

$$= \frac{2}{3}\left(2\sqrt{2}-1\right) = 1.22$$

86. In Taylor's series expansion of exp (x) + sin (x) about the point $x = \pi$, the coefficient of $(x-\pi)^2$ is

(1) exp (π) (2) 0.5 exp (π)

(3) exp (π) + 1 (4) exp (π) –1

86. Ans: (2)

Sol: Let $f(x) = e^x + \sin x$

Taylor's series of f(x) about $x = \pi$ is

$$f(x) = f(\pi) + (x-\pi)f^1(\pi) + \frac{(x-\pi)^2}{2!}f^{11}(\pi) + ..$$

$f^1(x) = e^x + \cos x$

$f^{11}(x) = e^x - \sin x$

$f^{11}(\pi) = e^\pi$

$\therefore$ coefficient of $\frac{(x-\pi)^2}{2!} = \frac{f^{11}(\pi)}{2!} = \frac{e^\pi}{2}$

87. The function $f(x) = 2x^3 - 3x^2 - 36x + 2$ has its maxima at

(1) Only $x = -2$ (2) Only $x = 0$

(3) Only $x = 3$ (4) Both $x = -2$ and $x = 3$

87. Ans: (1)

Sol: $f(x) = 2x^3 - 3x^2 - 36x + 2$

$f^1(x) = 6x^2 - 6x - 36$

$f^{11}(x) = 12x - 6$

$f^1(x) = 0 \Rightarrow x^2 - x - 6 = 0$

$\Rightarrow x = 3, -2$

$f^{11}(3) = 30 > 0$

$f^{11}(-2) = -30 < 0$

$\therefore$ f(x) is maximum only at $x = -2$

88. The coefficient of the x^5 term in the Maclaurin polynomial for sin (2x) is

(1) 0 (2) 0.0083333

(3) 0.016667 (4) 0.26667

88. Ans: (4)

Sol: $f(x) = f(0) + f^{1}(0) + \frac{x^2}{2!} + f^{11}(0) + ...$

$\therefore$ coefficient of $x^5 = \frac{f^{v}(0)}{5!}$

$f(x) = \sin 2x$

$f^{I}(x) = 2\cos 2x$

$f^{II}(x) = -4\sin 2x$

$f^{III}(x) = -8\cos(2x)$

$f^{IV}(x) = 16\sin 2x$

$f^{v}(x) = 32\cos 2x$

$f^{v}(0) = 32$

$\therefore$ coefficient of $x^5 = \frac{32}{5!} = 0.26667$

89. In the matrix equation Px = q, which of the following is a necessary condition for the existence of at atleast one solution for the unknown vector x?

(1) Augmented matrix [pq] must have the same rank as matrix P

(2) Vector q must have only non-zero elements

(3) Matrix P must be singular

(4) Matrix P must be square

89. Ans: (1)

Sol: The system of AX = B is consistent if rank of A = Rank of augumented matrix [A | B]

$\therefore$ Option (1) is correct

90. If $(D^2 + 1)\, y = \sin x \sin 2x$, then the particular integral is

(1) $\frac{1}{4}x\sin x + \frac{1}{16}\cos 3x$ (2) $\frac{1}{4}x\sin x - \frac{1}{16}\cos 3x$

(3) $\frac{1}{4}x\sin 2x + \frac{1}{16}\cos 3x$ (4) $\frac{1}{4}x\sin 2x - \frac{1}{16}\cos 3x$

90. Ans: (1)

Sol: $$P.I = \frac{1}{D^2+1}(\sin x.\sin 2x)$$

$$= \frac{1}{2}\left[\frac{\cos x - \cos 3x}{D^2+1}\right]$$

$$= \frac{1}{2}\left[\left(\frac{\cos x}{D^2+1}\right) - \left(\frac{\cos 3x}{D^2+1}\right)\right]$$

$$= \frac{1}{2}\left[\left(\frac{x\sin x}{2}\right) - \left(\frac{\cos 3x}{-9+1}\right)\right]$$

$$= \frac{x\sin x}{4} + \frac{\cos 3x}{16}$$

91. If $x = uv$ and $v = \frac{u+v}{u-v}$, then $\frac{\partial(u,v)}{\partial(x,y)}$ is equal to

(1) $\frac{(u+v)^2}{2uv}$ (2) $\frac{(u+v)^2}{4uv}$

(3) $\frac{(u-v)^2}{4uv}$ (4) $\frac{(u-v)^2}{2uv}$

91. Ans: (3)

Sol: Given that

$$x = uv \quad ; \qquad y = \frac{u+v}{u-v}$$

$$J = \frac{\partial(x,y)}{\partial(u,v)} = \begin{vmatrix} \frac{\partial x}{\partial u} & \frac{\partial x}{\partial v} \\ \frac{\partial y}{\partial u} & \frac{\partial y}{\partial v} \end{vmatrix}$$

$$= \begin{vmatrix} v & u \\ \frac{-2v}{(u-v)^2} & \frac{2u}{(u-v)^2} \end{vmatrix} = \frac{4uv}{(4-v)^2}$$

$$\therefore \frac{\partial(u,v)}{\partial(x,y)} = \frac{1}{J} = \frac{(u-v)^2}{4uv}$$

92. If $\phi(x, y, z) = 0$, then the value of $\left(\frac{\partial z}{\partial y}\right)_x\left(\frac{\partial x}{\partial z}\right)_y\left(\frac{\partial y}{\partial x}\right)_z$ is equal to

(1) 0 (2) 1

(3) $-\frac{1}{2}$ (4) –1

92. Ans: (4)

Sol: $\phi(x, y, z) = 0$

Let $z = f(x, y)$

$\phi[x, y, \phi(x, y)] = 0$

Differentiating partially with respect to y.

$$F_y^1 + F_z^1\left(\frac{\partial z}{\partial y}\right) = 0$$

$$\Rightarrow\left(\frac{\partial z}{\partial y}\right) = -\frac{F_y^1}{F_z^1}$$

similarly $\left(\frac{\partial x}{\partial z}\right) = -\frac{F_z^1}{F_x^1}$

and $\frac{\partial y}{\partial x} = -\frac{F_z^1}{F_y^1}$

$$\therefore\left(\frac{\partial z}{\partial y}\right)_x\left(\frac{\partial x}{\partial z}\right)_y\left(\frac{\partial y}{\partial x}\right)_z = -1$$

93. Given a function $f(x, y) = 4x^2 + 6y^2 - 8x - 4y + 8$. The optimum value of f(x, y)

(1) is a minimum equal to 10/3

(2) is a maximum equal to 10/3

(3) is a minimum equal to 8/3

(4) is a maximum equal to 8/3

93. Ans: (1)

Sol: $f(x, y) = 4x^2 + 6y^2 - 8x - 4y + 8$

$f_x = 8x - 8$

$f_y = 12y - 4$

$r = f_{x_x} = 8,\ s = f_{x_y}\quad t = f_{y_y} = 12$

Solving $f_x = 0$ and $f_y = 0$

$\Rightarrow (x, y) = \left(1, \frac{1}{3}\right)$ is a stationary point

At $\left(1, \frac{1}{3}\right)$, $rt - s^2 = 6 > 0$

and $r = 8 > 0$

$\therefore$ f(x, y) has a minimum at $\left(1, \frac{1}{3}\right)$

$\therefore$ The minimum value $f\left(1, \frac{1}{3}\right) = \frac{10}{3}$

94. For $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = \frac{e^{3x}}{x^2}$, the particular integral is

(1) $e^{-3x}(1+ \log x)$ (2) $-e^{-3x}(1+ \log x)$

(3) $e^{3x}(1+ \log x)$ (4) $-e^{3x}(1+ \log x)$

94. Ans: (4)

Sol: $(D^2 - 6D + 9)\ y = \frac{e^{3x}}{x^2} = (P \text{ say})$

AE is $m^2 - 6m + 9 = 0$

$m = 3, 3$

$CF = C_1 e^{3x} + C_2 (x. e^{3x})$

$= C_1 y_1 + C_2 y_2$ (say)

Let P.I = $u y_1 + v y_2$

$$u = \int \frac{-Py_2}{w}\,dx = \int \frac{-\frac{e^{3x}}{x^2}\left(x\,e^{3x}\right)}{e^{6x}}dx$$

$$= \int -\frac{1}{x}dx = -\log x$$

$$v = \int \frac{Py_1}{w}dx = \int \frac{\frac{e^{3x}}{x^2}\left(e^{3x}\right)}{e^{6x}}\,dx = \frac{-1}{x}$$

$$P.I = (-\log x)e^{3x} - \frac{1}{x}\left(xe^{3x}\right)$$

95. $\int_0^{\pi/2} \frac{\log\left(1+a\sin^2 x\right)}{\sin^2 x}dx$ is also shown as

(1) $\pi\left(\sqrt{a-1}+1\right)$ (2) $\pi\left(\sqrt{a+1}-1\right)$

(3) $\frac{\pi}{2}\left(\sqrt{a+1}-1\right)$ (4) $\pi\left(\sqrt{a-1}-1\right)$

95. Ans: (2)

Sol: Let $I = \int \frac{\log\left(1+a\sin^2 x\right)}{\sin^2 x}\,dx$

Then $I = \int \underbrace{\operatorname{cosec}^{2`}(x)}_{u}.\ \underbrace{\log\left(1+a\sin^2(x)\right)}_{v}dx$ (using by parts)

$$\Rightarrow I = \left[(-\cot x).\log\left(1+a\sin^2 x\right)\right] + \int \frac{2.a.\sin x\cos x}{1+a\sin^2 x}\cot x\,dx$$

$$\Rightarrow I = \left[-\cot x.\log\left(1+a\sin^2 x\right)\right] + 2\underbrace{\int \frac{a\cos^2 x}{1+a\sin^2 x}dx}_{I_1}$$

Consider $I_1 = \int \frac{a\cos^2 x}{1+a\sin^2 x}dx$

$$\Rightarrow \quad I_1 = \int \frac{a\left(1+\cos^2 x-1\right)}{1+a\sin^2 x}\,dx$$

$$\Rightarrow \quad I_1 = \int \frac{a+a\cos^2 x-a}{1+a\sin^2 x}\,dx \qquad [\because \sin^2 x + \cos^2 = 1 \ \&\ a\sin^2 x + a\cos^2 x = a]$$

$$\Rightarrow \quad I_1 = \int \frac{a - a\sin^2 x}{1 + a\sin^2 x}\, dx$$

$$\Rightarrow \quad I_1 = \int \frac{a}{1 + a\sin^2 x} dx - \int \frac{a\sin^2 x}{1 + a\sin^2 x}\, dx$$

$$\Rightarrow \quad I_1 = \int \frac{a}{1 + a\sin^2 x} dx - \int \frac{(1 + a\sin^2 x) - 1}{1 + a\sin^2 x}\, dx$$

$$\Rightarrow \quad I_1 = \int \frac{a}{1 + a\sin^2 x}\, dx - \int 1\, dx + \int \frac{1}{1 + a\sin^2 x}\, dx$$

$$\Rightarrow \quad I_1 = \underbrace{(1+a)\int \frac{1}{1 + a\sin^2 x}\, dx}_{I_2} - x$$

Again $I_2 = (1+a)\int \frac{1}{1 + a\sin^2 x}\, dx$

$$\Rightarrow \quad I_2 = (1+a)\int \frac{1}{\cos^2 x + \sin^2 x + a\sin^2 x}\, dx$$

$$\Rightarrow \quad I_2 = (1+a)\int \frac{1}{\cos^2 x + (1+a)\sin^2 x}\, dx$$

$$\Rightarrow \quad I_2 = (1+a)\int \frac{\sec^2 x}{1 + (1+a)\tan^2 x}\, dx$$

$$\Rightarrow \quad I_2 = (1+a)\int \frac{dt}{1 + (1+a)t^2} \qquad [\because \tan x = t \ \& \ \sec^2 x\, dx = dt]$$

$$\Rightarrow \quad I_2 = (1+a)\int \frac{1}{(1+a)\left[\left(\frac{1}{\sqrt{1+a}}\right)^2 + t^2\right]}\, dt$$

$$\Rightarrow \quad I_2 = \frac{1}{\left(\frac{1}{\sqrt{1+a}}\right)} \cdot \tan^{-1}\left(\frac{t}{\frac{1}{\sqrt{1+a}}}\right)$$

$$\Rightarrow \quad I_2 = \sqrt{1+a}\ \tan^{-1}\left(\sqrt{1+a}\,.\tan x\right)$$

Now, $I_1 = I_2 - x$

$\Rightarrow I_1 = \sqrt{1+a}\,.\tan^{-1}\left[\sqrt{1+a}\tan x\right] - x$

Again $I = [-\cot x.\log(1 + a\sin^2 x] + 2\,I_1$

$\Rightarrow I = [-\cot x.\log(1 + a\sin^2 x)] + 2\left[\sqrt{1+a}\,.\tan^{-1}\left(\sqrt{1+a}.\tan x\right) - x\right]$

Now, $I = \int \frac{\log\left(1+a\sin^2 x\right)}{\sin^2 x}\,dx$

$\Rightarrow (I)_0^{\frac{\pi}{2}} = \left\{\left[-\cot x.\log\left(1+a\sin^2 x\right)\right] + 2\left[\sqrt{1+a}.\tan^{-1}\left(\sqrt{1+a}\tan x\right) - x\right]\right\}_0^{\frac{\pi}{2}}$

$= \left[0 + 2\left(\sqrt{1+a}.\frac{\pi}{2} - \frac{\pi}{2}\right)\right] - [0 + 2(0-0)]$

$\therefore \int_0^{\pi/2} \frac{\log\left(1+a\sin^2 x\right)}{\sin^2 x}\,dx = \pi\left[\sqrt{1+a} - 1\right]$

96. The partial differential equation $5\frac{\partial^2 z}{\partial x^2} + 6\frac{\partial^2 z}{\partial y^2} = xy$ is classified as

(1) elliptic (2) parabolic

(3) hyperbolic (4) None of these

96. Ans: (1)

Sol: $5\frac{\partial^2 z}{\partial x^2} + 6\frac{\partial^2 z}{\partial y^2} = xy$

The equation

$A\frac{\partial^2 u}{\partial x^2} + B\frac{\partial^2 u}{\partial x \partial y} + C\frac{\partial^2 u}{\partial y^2} + D\frac{\partial u}{\partial y} + E\frac{\partial u}{\partial y} + Fu = y$ is

Elliptic if $B^2 - 4AC < 0$

Parabolic if $B^2 - 4AC = 0$

Hyperbolic $B^2 - 4AC > 0$.

Here, A = 5, B = 0, C = 6

$B^2 - 4AC = -120 < 0$

$\therefore$ The equation is elliptic

97. The are of the curve $a^2 x^2 = y^3 (2a–y)$ is found out to be

(1) πa (2) πa^3

(3) $\pi^2 a$ (4) πa^2

97. Ans: (4)

Sol: Let us first find the limits of integration.

i. The curve is symmetrical about y-axis.

ii. It passes through the origin and the tangents at the origin are $x^2 = 0$ or $x = 0, x = 0$

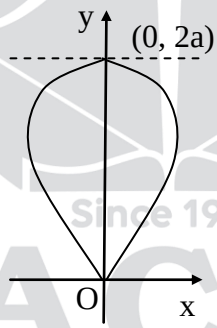
$\therefore$ There is a cusp at the origin.

iii. The curve has no asymptote.

iv. The curve meets the x-axis at the origin only and meets the y-axis at (0, 2a). Form

$$x = \frac{y}{a}\sqrt{[\{y(2a-y)\}]}$$

For $y < 0$ or $y > 2a$, x is imaginary. Thus the curve entirely lies between $y = 0$ (x-axis) and $y = 2a$, which is shown in figure.



$\therefore$ Area of the curve $= 2\int_0^{2a} x\,dy = \frac{2}{a}\int_0^{2a} y\sqrt{[y(2a-y)]}\,dy$

|Put $y = 2a\sin^2\theta$ $\therefore$ $dy = 4a\sin\theta\cos\theta\,d\theta$

$$= \frac{2}{a}\int_0^{\pi/2} 2a\sin^2\theta\sqrt{[2a\sin^2\theta(2a-2a\sin^2\theta)]}\times 4a\sin\theta\cos\theta\,d\theta$$

$$= 32a^2\int_0^{\pi/2}\sin^4\theta\cos^2\theta\,d\theta = 32a^2\frac{3.1\times 1}{6.4.2}.\frac{\pi}{2} = \pi a^2$$

98. Consider the equation:

$$y'' + \left(\frac{x^2.\sin(x)}{e^2\sqrt{\pi}}\right)^8 (y')^3 + xy = 10, \text{ is}$$

(1) an ordinary linear differential equation of order 2

(2) an ordinary non-linear differential equation of order 2

(3) an ordinary linear differential equation of order 3

(4) an ordinary non-linear differential equation of order 3

98. Ans: (2)

Sol: The highest order derivative = y^{11}

$\therefore$ The given equation is not linear because (y^1) is not first degree.

$\therefore$ The given equation is an ordinary non linear differential equation of second order.

99. Matrix $[A] = \begin{bmatrix} 4 & 2 & 1 & 3 \\ 6 & 3 & 4 & 7 \\ 2 & 1 & 0 & 1 \end{bmatrix}$

The rank of matrix is

(1) 4 (2) 1

(3) 3 (4) 2

99. Ans: (4)

Sol: $A = \begin{bmatrix} 4 & 2 & 1 & 3 \\ 6 & 3 & 4 & 7 \\ 2 & 1 & 0 & 1 \end{bmatrix}$

$R_1 \leftrightarrow R_3$

$$A \sim \begin{bmatrix} 2 & 1 & 0 & 1 \\ 6 & 3 & 4 & 7 \\ 4 & 2 & 1 & 3 \end{bmatrix}$$

$R_2 - 3R_1$ $R_3 - 2R_1$

$$A \sim \begin{bmatrix} 2 & 1 & 0 & 1 \\ 0 & 0 & 4 & 4 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

$R_2 - 4R_1$

$$A \sim \begin{bmatrix} 2 & 1 & 0 & 1 \\ 0 & 0 & 4 & 4 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$ = An echelon matrix with two non zero rows

$\therefore$ Rank of A = 2

100. Choose the correct set function which are linearly dependent

(1) sin x, $\sin^2 x$ and $\cos^2$ x (2) cos x, sin x and tan x

(3) cos 2x, $\sin^2 x$ and $\cos^2 x$ (4) cos 2x, sin x and cos x

100. Ans: (3)

Sol: A set of functions in linearly dependent if we can write each function as a linear combination of other two.

If the functions f(x), g(x) and h(x) are linearly dependent, then we can find constant a and b such that f(x) = a.g(x) + b.h(x)

Here,

$\cos^2 x = \cos^2 x - \sin^2 x$

$\therefore$ The functions cos2x, $\sin^2 x$ and $\cos^2 x$ are linearly dependant.