

B.Tech 2nd Semester Exam., 2022

(New Course)

ENGINEERING GRAPHICS AND DESIGN

Time : 3 hours Full Marks : 70

Instructions : *Instructions are given below*

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. **1** is compulsory.

1. Choose the correct answer (any seven) :

$$2 \times 7 = 14$$

(a) Which type of line is particular to section drawings?

- (i) Break lines
- (ii) Phantom lines
- (iii) Extension lines
- (iv) Cutting plane lines

(2)

(b) which one of the following is not a reducing scale?

- (i) 1:1
- (ii) 1:200
- (iii) 5/320
- (iv) 5:6

(c) What type of curve is created by the intersection of a plane parallel to the side of cone?

- (i) Parabola
- (ii) Hyperbola
- (iii) Ellipse
- (iv) Roulette

(d) The straight line of projection will make an angle with xy line to the angle of plane with the other principal plane.

- (i) Perpendicular
- (ii) Equal
- (iii) Right angle
- (iv) Zero

(3)

(e) The intersection of a plane surface with the horizontal plane is a line and is called

- (i) horizontal trace
- (ii) vertical trace
- (iii) profile trace
- (iv) trace

(f) The solid having polygon for a base and triangular lateral faces intersecting at a vertex is

- (i) pyramid
- (ii) prism
- (iii) cone
- (iv) torus

(g) What types of sketch are typically used in the refinement stage of the design process?

- (i) Isometric
- (ii) Document
- (iii) Oblique
- (iv) Ideation

(4)

Inclined planes in a three-view drawing will appear as

- (i) two surfaces and one edge
 - (ii) two edges and one surface
 - (iii) three edges
 - (iv) foreshortened in each view
- (i) The primary difference between the model tab and the layout tab is
- (i) the model tab is used for drawing in 3D and a layout is used for drawing in 2D
- (ii) the model tab is where you create the drawing and a layout tab represents the sheet that you will plot or print on the color of the background
- (iii) the model tab displays the drawing you are copying from and the layout tab is where you layout the new drawing
- (iv) None of the above

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(5)

Q) Which of the following is not a property of an object?

- (i) Line weight
- (ii) Measure
- (iii) Hyperlink
- (iv) Elevation

2. On a road map, a scale of miles is shown.

On measuring from this scale, a distance of 25 miles is shown by a line 10 cm long. Construct this scale to read miles and to measure up to 40 miles. Construct a comparative scale, attached to this scale, to read kilometres up to 60 kilometres. [1 mile = 1.609 km.]

14

3. A thin circular disc of 50 mm diameter is allowed to roll without slipping from upper edge of sloping plank which is inclined at 15° with the horizontal plane. Draw the curve traced by the point on the circumference of the disc.
4. The line AB is 75 mm long and it is 30° and 40° inclined to HP and VP respectively. End A is 12 mm above HP and 10 mm in front of VP. Draw its projections. The line is in first quadrant.

14

(Continued)

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(Turn Over)

(6)

5. Determine the true shape of the figure, the top view of which is a regular pentagon of 35 mm sides, having one side inclined at 30° to reference line and whose front view is a straight line making an angle of 45° to reference line.

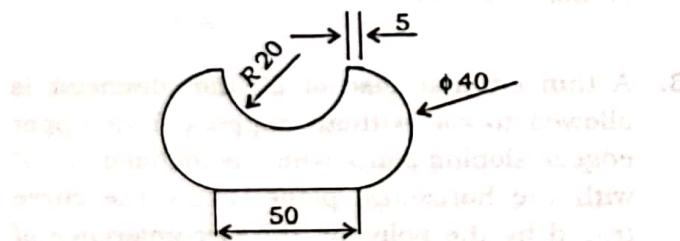
14

6. A square pyramid, base 40 mm side and axis 65 mm long, has its base in the VP. One edge of the base is inclined at 30° to the HP and a corner contained by that edge is on the HP. Draw its projections.

14

7. Draw a line diagram as shown, using relative polar coordinate method :

14



8. An air-conditioning duct of a square cross-section 70 mm \times 70 mm connects a circular pipe of 40 mm diameter through the transition piece. Draw the projections and develop the lateral surface of the transition piece.

14

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(Continued)

(7)

9. Draw the isometric view of a cone, base 40 mm diameter and axis 55 mm long (i) when its axis is vertical and (ii) when its axis is horizontal.

14

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MATHEMATICS-II

(Probability and Statistics)

Time : 3 hours Full Marks : 70

Instructions :

- The marks are indicated in the right-hand margin.
- There are **NINE** questions in this paper.
- Attempt **FIVE** questions in all.
- Question No. 1 is compulsory.

1. Choose the correct option of the following
 (any seven) : $2 \times 7 = 14$

- (a) Given $P(A) = 0.35$, $P(B) = 0.63$ and
 $P(A \cap B) = 0.32$. Find $P(B|A)$.
- (i) $32/63$
 (ii) $32/35$
 (iii) $7/20$
 (iv) It cannot be determined from the information given

(2)

- (b) For which of the following experiments is the binomial distribution an appropriate model of the experiment's probability distribution?

- (i) Toss a six-sided fair die 30 times and record the up face of the die
- (ii) Toss a six-sided fair die 100 times and record the number of times the up face of the die shows five dots
- (iii) Count the number of cars entering a car wash in a 30-minute period
- (iv) Randomly draw 30 cards, successively without replacement, from a well-shuffled deck of 52 playing cards, and observe whether the card is a diamond

- (c) Consider the normal random variable X with mean $\mu = 200$ and standard deviation $\sigma = 25$. Which of the following statements is always true?

- (i) $P(X < 200)$ is less than $P(X > 200)$
- (ii) $P(X < 200)$ is greater than $P(X > 200)$
- (iii) $P(X = 200)$ equals 0
- (iv) $P(X = 200)$ equals 0.5

(3)

- (d) If the moment-generating function of a continuous random variable X be given as

$$M_X(t) = (1-t)^{-9}, |t| < 1$$

Then its mean and variance is

(i) (9, 1/9)

(ii) (9, 9)

(iii) (3, 3)

(iv) (1/9, 1/9)

- (e) Which one of the following statements is always true?

- (i) The greater the value of the correlation coefficient, the stronger is the relationship.

- (ii) A strong positive correlation between two variables means one of the variables causes the effect of the other variable.

- (iii) If two variables are independent, their correlation does not exist.

- (iv) Pearson product-moment correlation coefficients numerically quantify only linear relationships.

(f) The variance of first n natural number is

(i) $\frac{n^2 + 1}{12}$

(ii) $\frac{(n+1)^2}{12}$

(iii) $\frac{n^2 - 1}{12}$

(iv) $\frac{2n^2 - 1}{8}$

(g) Kurtosis in frequency distribution is adjudged around

(i) second quartile

(ii) arithmetic mean

(iii) quadratic mean

(iv) mode

(h) Which one of the following statements is always true?

(i) If H_0 contains \neq , the hypothesis test is two-tailed.

(ii) If H_a contains $>$, the hypothesis test is left-tailed.

(iii) If H_a contains \neq , the hypothesis test is two-tailed.

(iv) If H_0 contains \leq , the hypothesis test is left-tailed.

(i) Which of the following symbols is commonly used for the population variance?

(i) σ least frequent arbitrary letter

(ii) σ^2 standard deviation

(iii) s standard deviation

(iv) s^2 standard deviation

(j) Use of the chi-square statistics requires that each of the expected cell counts is

(i) at least 10

(ii) not more than 10

(iii) at least 5

(iv) not more than 5

2. (a) The manufacturing department of a company hires technicians who are college graduates as well as technicians who are not college graduates. Under their diversity program, the manager of any given department is careful to hire

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both male and female technicians. The data in table given below show a classification of all technicians in a selected department by qualification and gender. Suppose that the manager promotes one of the technicians to a supervisory position. If the promoted technician is a woman, then what is the probability that she is a non-graduate?

8

Classification of technicians by qualification and gender

	Graduates	non-graduates	Total
Male	20	36	56
Female	15	29	44
Total	35	65	100

(b) A random variable X has the following probability function :

6

Values of X , x	-3	-1	0	1	2	3	5	8
$p(x)$	0.10	0.30	0.45	0.50	0.75	0.90	0.95	1.00

(i) Find mean and variance of random variable X .

(ii) Find $P(X = -3 | X < 0)$ and $P(X \geq 3 | X > 0)$.

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(Continued)

(7)

3. (a) An irregular six-faced die is thrown and the expectation that in 10 throws it will give five even numbers is twice the expectation that it will give four even numbers. How many times in 10000 sets of 10 throws each you would expect it to give no even number?

7

(b) If a sample size n is taken from a lot of N items containing 10% defectives, show by using the Chebyshev's inequality that the probability exceeds 0.99 that the number of defectives in the sample differs from $n/10$ by not more than $3\sqrt{n}\sqrt{(N-n)/(N-1)}$.

7

4. (a) Find the mean of normal distribution.

7

(b) Suppose that the lapse of time between two successive accidents in a paper mill is exponentially distributed with a mean of 15 days. Find the probability that the time between two successive accidents at that mill is more than 20 days.

7

5. Three coins are tossed. Let X denote the number of heads on the first two coins,

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(Turn Over)

(8)

Y denote the number of tails on the last two and Z denote the number of heads on the last two.

(a) Find the joint distribution of (i) X and Y ,

(ii) X and Z .

(b) Find the conditional distribution of Y given $X = 1$.

(c) Find $E(Z | X = 1)$.

(d) Find $\rho_{X,Y}$ and $\rho_{X,Z}$.

(e) Give a joint distribution that is not the joint distribution of X and Z in part (a) and yet has the same marginals as $f(x, z)$ has in part (a).

6. (a) Find the first four moments (i) about the origin and (ii) about the mean for a random variable X having density function

$$f(x) = \begin{cases} 4x(9-x^2)/81, & 0 \leq x \leq 3 \\ 0, & \text{otherwise} \end{cases}$$

6

(Continued)

(9)

(b) The number of defective parts produced per shift can be modeled using a random variable that has the Poisson distribution. Assume that, on average, three defective parts per shift are produced.

(i) What is the probability that exactly four defective parts are produced in a given shift?

(ii) What is the probability that more than seven defective parts are produced in the next two shifts?

7. (a) A manufacturer knows from experience that the diameters of 0.250 in. precision-made pins he produces have a normal distribution with mean 0.25000 in. and standard deviation 0.00025 in. What percentages of the pins have diameters between 0.24951 in. and 0.25049 in? This question is equivalent to find the probability that the diameter, say X , of a pin taken at random from the production lies between 0.24951 in. and 0.25049 in.

8

7

(10)

(b) Fit a straight line to the following data :

7

X	1	2	3	4	5	6	7
Y	2.4	3	3.6	4	5	6	

8. (a) The variables X and Y are connected by the equation $aX + bY + c = 0$. Show that the correlation between them is -1 , if the signs of a and b are alike and $+1$, between if the signs of a and b are different.

7

(b) A random sample of 500 apples was

- taken from a large consignment and 60 were found to be bad. Obtain the 98% confidence limits for the percentage of bad apples in the consignment.

7

- (b) Describe the chi-squared test for testing a hypothesis that a normal population has a specified variance σ^2 .

7

Area Under Standard Normal Curve $P(0 < Z < z)$

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0598	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1738	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
0.7	.2580	.2611	.2642	.2674	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4865	.4868	.4871	.4874	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986	
3.0	.4986	.4987	.4987	.4988	.4988	.4989	.4989	.4990	.4990	

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(New Course)

PHYSICS

**(Semiconductor Physics and Introduction
to Quantum Mechanics)**

Time : 3 hours Full Marks : 70

Instructions :

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. **1** is compulsory.
- (v) Symbols used (if any) have their usual meanings.

1. Answer any seven questions : $2 \times 7 = 14$

- (a) What is the unit of mobility of charge carriers?
- (b) Give examples of direct band semiconductor.

QUESTION (2)

- (c) What is de Broglie wavelength of an electron which has been accelerated from rest through a potential difference of 100 V?
- Given :
- Mass of electron = 9.1×10^{-31} kg
 Planck's constant = 6.62×10^{-34} Js
- (d) Define Fermi level.
- (e) Define expectation value.
- (f) What are the types of photodetectors?
- (g) Find uncertainty in the momentum of a particle when its position is determined within 0.01 cm.
- (h) Define population inversion.
- (i) What do you mean by diffusion in carrier transport?
- (j) Write two advantages of LED over ordinary incandescent lamp.
2. (a) Derive the expression for equilibrium concentration of electrons in conduction band.

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(3)

- (b) Calculate the equilibrium concentration of electrons in silicon at $T = 300$ K. Assume, the Fermi energy is 0.25 eV below the conduction band. The value of effective density of state function in conduction (N_c) for silicon at 300 K = 2.8×10^{19} cm⁻³, value of kT at 300 K = 0.0259 eV.
- 4
3. Discuss the Kronig-Penney model for the motion of an electron in a periodic potential. Plot total energy of an electron in a periodic potential versus wave number, i.e., $\epsilon-k$ graph. 14
4. Write short notes on the following : 7+7=14
- (a) Compton effect
- (b) Photoelectric effect
5. Discuss the structure, working principle and characteristics of PIN and Avalanche photodiodes. 14
6. What is non-radiative recombination mechanism? Discuss the processes involved in non-radiative recombination in detail. 14

(4)

- 7.** Derive an expression for effective mass of an electron. What is the significance of negative effective mass? 10+4=14

8. What are LEDs? Sketch the relative eye response as a function of wavelength. Describe device structure and materials used for LED with its characteristics. 14

9. Write short notes on the following : 7+7=14

 - (a) Density of states
 - (b) Free electron model
 - (c) Fermi level
 - (d) Selection rules for transitions

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B.Tech 2nd Semester Exam., 2022

(New Course)

BASIC ELECTRICAL ENGINEERING

Time : 3 hours Full Marks : 70

Instructions :

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. 1 is compulsory.

1. Short answer-type questions (any seven) :

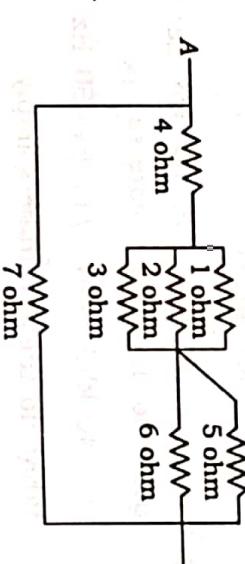
$2 \times 7 = 14$

- (a) State and explain Kirchhoff's laws with an example.
- (b) Which winding (LV or HV) should be kept open while conducting OC test? Justify your answer.
- (c) Assume that the given transformer has the following name plate ratings :
40 kVA, 440 V/11 kV, 50 Hz
What do these numbers imply?

(2)

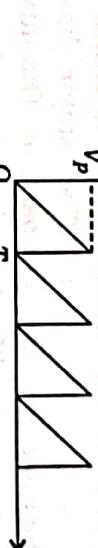
- (d) What is a commutator in d.c. machine?
- (e) What is meant by linear network? Explain R, L and C as linear elements.
- (f) Differentiate among real, reactive and apparent powers.
- (g) Calculate maximum value and r.m.s. value of $v = 10\sin \omega t - 17.3\cos \omega t$.
- (h) A 250 V bulb passes a current of 0.3 A. Calculate the power in the lamp.
- (i) Define unilateral and bilateral elements.
- (j) Give some applications of three-phase induction motor.

2. (a) An a.c. current varying sinusoidal with frequency 50 Hz has r.m.s. value 20 A. Write equation for instantaneous value and find this value 0.0125 seconds after passing through maximum value.
- (b) Calculate the resistance between A and B from the figure given below :



(3)

3. (a) Explain the r.m.s. value. Solve the V_{rms} value of given waveform in the figure:



- (b) Two coils, connected in series-aiding fashion, have a total inductance of 250 mH. When connected in a series-opposing configuration, the coils have a total inductance of 150 mH. If the inductance of one coil (L_1) is three times the other, then find L_1 , L_2 and M . What is the coupling coefficient?

4. (a) Explain the principle of transformer action.

- (b) A series circuit consists of a resistance of 4Ω , an inductance of 500 mH and a variable capacitance connected across a 100 V , 50 Hz supply. Calculate the capacitance required for producing a series resonance condition, and the voltages generated across both the inductor and the capacitor at the point of resonance.

5. (a) Define parallel resonance. Calculate at resonance the resultant current and quality factor in terms of the parameters of a circuit.

- (b) Explain the advantages of rotating field-type alternator. 8
6. A 3-phase, 6-pole, star-connected alternator revolves at 1000 r.p.m. The stator has 90 slots and 8 conductors per slot. The flux per pole is 0.05 Wb. Calculate the voltage generated, if $K_w = 0.96$. 14
7. (a) Explain the principle of operation of d.c. motor. 6
 (b) A balanced star-connected load of $(8 + j6) \Omega$ per phase is connected to a balanced 3-phase, 400 V supply. Find the line current, power factor, power and total volt-amperes. 8
8. A 6-pole alternator runs at 1000 r.p.m., and supplies power to a 4-pole, 3-phase induction motor. The frequency of rotor of induction motor is 2 Hz. Determine the slip and speed of the motor. 14
9. Two coils, X of 12000 turns and Y of 15000 turns, lie in parallel planes so that 45% of the flux produced by coil X links coil Y. A current of 5 A in X produces 0.05 Wb while the same current in Y produces 0.075 Wb. Calculate (a) the mutual inductance, (b) the coupling coefficient and (c) the percentage of flux produced by coil Y and linking with coil X. 14

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