NATIONAL INSTITUTE OF TECHNOLOGY PATNA

DEPARTMENT OF MATHEMATICS

END SEMESTER EXAMINATION – MAY 2025

COURSE: ENGINEERING MATHEMATICS – II

CODE: MA28101/MA21110

Time: 3 hours

Maximum Marks: $6 \times 10 = 60$

*Answer **all** questions*

1. (a) Prove that

$$\int_0^1 \frac{x^{m-1}(1-x)^{n-1}}{(b+cx)^{m+n}}dx = \frac{1}{b^n(b+c)^m}\beta(m,n), \qquad m,n,b,(b+c) > 0.$$

(b) Prove that, for $m,\ n > 0$, $\int_0^1 \frac{x^{m-1}+x^{n-1}}{(1+x)^{m+n}}dx = \beta(m,n)$.

2. (a) Evaluate $\iint_D e^{y/x}dxdy$ where D is the triangle bounded by $y = x,\ y = 0$ and $x = 1$.

(b) Evaluate $\int_0^a dx \int_0^{\sqrt{a^2-x^2}} \log(1+x^2+y^2)dy$.

3. Prove that

$$\nabla \times (\nabla \times \mathbf{A}) = -\nabla^2\mathbf{A} + \nabla(\nabla \cdot \mathbf{A}).$$

4. Let $\vec{F} = 3xyz^2\hat{i} + 2xy^3\hat{j} - x^2yz\hat{k}$ and $\phi = 3x^2 - yz$. Find, at the point $(1,-1,1)$, (i) $\nabla \cdot \vec{F}$, (ii) $\vec{F} \cdot \nabla\phi$, (iii) $\nabla \cdot (\phi\vec{F})$, and (iv) $\nabla \cdot \nabla\phi$.

5. Show that $\mathbf{F} = (2xy+z^3)\mathbf{i}+x^2\mathbf{j}+3xz^2\mathbf{k}$ is a conservative force field. Find the scalar potential. Find the work done in moving an object in this field from (1,-2,1) to (3,1,4).

6. Verify the divergence theorem for $\mathbf{A} = 4x\mathbf{i} - 2y^2\mathbf{j} + z^2\mathbf{k}$ taken over the region bounded by $x^2 + y^2 = 4,\ z = 0$ and $z = 3$.

7. (a) Expand $f(z) = \sin z$ in a Taylor series about $z = \frac{\pi}{4}$. Hence find the regions of convergence of that series.

(b) Find Laurent series of the function $f(z) = (z-3)\sin\left(\frac{1}{z+2}\right)$ about $z = -2$.

8. (a) Evaluate the integral $\int_0^\pi \frac{d\theta}{(a+\cos\theta)^2}$, $a > 1$ using contour integration method.

(b) Show that $\frac{1}{2\pi i}\oint_C \frac{e^{zt}}{z^2+1}dz = \sin t$ if $t > 0$, and C is the circle $|z| = 3$.

9. A random variable X is distributed at random between the values 0 and 4 and its probability density function is given by $f(x) = kx^3(4-x^2)$. (i) Find the value of k, (ii) find the mean and variance of the distribution.

10. The probability function of a random variable X is given by

x	1	2	3
f(x)	1/2	1/3	1/6

Determine the distribution function. Hence deduce $P(1 \le X \le 3)$, $P(X \ge 2)$, $P(X < 3)$ and $P(X > 1.4)$.

** * * * **

2411016

National Institute of Technology Patna

Department of Mechatronics and Automation Engineering

End Semester Examination, Jan-June 2025

Subject: Fundamentals of Machine Tools
Branch: Mechatronics and Automation Engineering
Date: 29/04/2025 (FN)
Batch: 2024-28

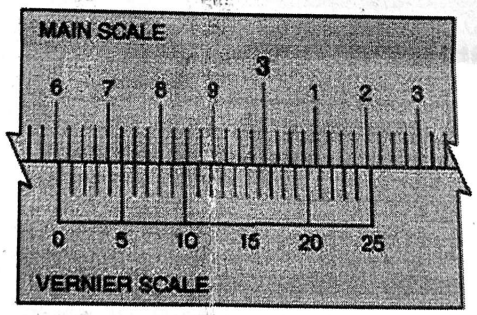
Subject Code: MAE21101
Semester: II
Total Time: 3 hr
Total Marks: 60

Part-A **Answer ALL the questions** **(5×4=20)**

Q.No	Questions
1.	What do you mean by mechanics of metal cutting? Draw the Merchant's circle diagram.
2.	Compare turning and milling process.
3.	A drill bit of diameter 25 mm has cutting speed of 15.7 mm/min. What is the speed of rotation of drill?
4.	Discuss the specifications and cutting parameters of shaper machine.
5.	Discuss external and internal centerless grinding.

Part-B **(5×8=40)**

6.	**(a)** Draw the diagram of single point cutting tool. Discuss the terminology of single point cutting tool in detail. Write the tool signature of 0-7-6-8-15-16-0.8 in American Standards Association (ASA) system of tool designation.
	Or
	(b) In an orthogonal cutting operation, the following data have been observed: uncut chip thickness = 0.127 mm, width of cut = 6.35 mm, cutting speed = 2 m/s, rake angle = 10°, cutting force = 567 N, thrust force = 227 N, Chip Thickness = 0.228 mm, Determine the shear angle, the friction angle, shear stress along the shear plane, and the power for the cutting operation. Also find the chip velocity, shear strain in chip, and the strain rate.
7.	**(a)** Discuss the working principle of shaper machine. Draw and discuss its main parts. Also Discuss different types of quick return mechanism.
	Or
	(b) Discuss the principle of planer machine. Draw and discuss the main parts of planer machine. Also compare planer and shaper machine.

8.	(a) Draw and discuss basic parts of bench grinding machine. Write the ISO designation of grinding wheel in detail.	
	Or	
	(b) Discuss different types of abrading process. A mild steel rod of 200 mm length and 50 mm diameter is to be reduced to 45 mm diameter in a single pass on a lathe. The cutting speed is 30 m/min and feed is 0.3 mm/rev. Find the time taken to complete the operation.	
9.	(a) Discuss the principle of milling machine. Draw and discuss the main parts of plain milling machine. Also discuss four different milling operation with diagram.	
	Or	
	(b) A student got a project in which a job is given to do facing and turning operation on lathe machine. The student found the following reading on Vernier scale during checking the dimension after facing operation. Write the measurement reading shown in the following scale if the least count is 0.02mm.  While turning a workpiece of 60 mm diameter at 300 rpm with a feed of 0.2 mm/rev and depth of cut 2 mm, the cutting force measured is 800 N. Calculate the power required in kilowatts.	
10.	(a) Discuss eight causes of wear and wear reduction method.	
	Or	
	(b) Discuss the causes of heat generation during metal cutting. What are the properties required for the cutting fluid? Write the name of cutting fluid and how it is different from the lubricant.	

NATIONAL INSTITUTE OF TECHNOLOGY PATNA

Department of Chemical Science & Technology

END SEMESTER EXAMINATION, May 2025

B. Tech: Semester-II, MAE, APME & MCT

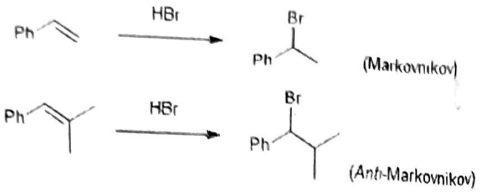
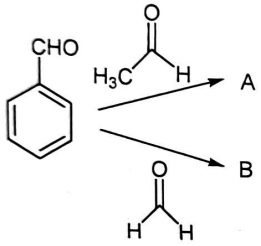
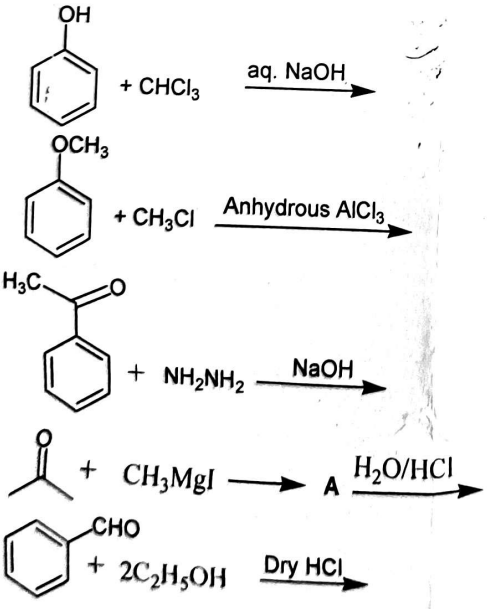
Course Name: Engineering Chemistry; Course Code: CH211101, CH28101 & CH27101

Maximum Time: 3 hours **Max. Marks: 60.....**

Instruction:

1. Attempt All questions.
2. Assume any suitable data, if necessary.

		Marks	CO	BL
1. a).	Explain how the straight run naphtha is converted into high-octane number petrol (gasoline) by the catalytic process.	3	CO1	L4
b).	How to determine the Flash and fire point of petroleum fuel?	2	CO2	L5
c).	How knocking is produced in an internal combustion engine and mention its working structure. Write the process to overcome the knocking sound produced in an engine.	3	CO2	L5
d).	Write the advantages of conductometric titrations. Discuss the precipitation titration curves with suitable example.	2	CO3	L4
2. a).	Deduce and explain the Nernst equation. What is the significance of Nernst equation?	5	CO3	L4
b).	Calculate the solubility product of $BaSO_4$ is 1.1×10^{-10} mol^2/dm^3. If the $\lambda^\circ(Ba^{2-})$ is 127.28×10^{-4} Ω-$1m^2mol^{-1}$ and SO_4^{2-} is 160×10^{-4} Ω-$1m^2mol^{-1}$. Calculate the sp. conductance of $BaSO_4$ in SI.	3	CO5	L5
c).	State and explain Kohlrauschs`s law of independent migration of ions. How does it help in determining the equivalent conductivity at infinite dilution of weak electrolytes?	2	CO5	L5
3. a).	Explain the shape of the molecules having all follow sp^3d hybridization, PCl_5, SF_4, BrF_3, and XeF_2, based on the principle of VSEPR theory.	3	CO2	L3
b).	Explain that CFSE varies compound to compound. Calculate the CFSE of the following complexes: i. $[Co(H_2O)_6]^{2+}$, ii. $[Ti(H_2O)_6]^{3+}$, iii. $[RhCl_6]^{3-}$ iv. $[Ir(NH_3)_6]^{3+}$.	3	CO3	L4
c).	Among the complex ions, $[Co(NH_2.CH_2.CH_2.NH_2)_2Cl_2]^+$, $[CrCl_2(C_2O_4)_2]^{3-}$, $[Fe(H_2O)_4(OH)_2]^+$, $[Fe(NH_3)_2(CN)_4]^-$, $[Co(NH_2-CH_2-NH_2)_2(NH_3)Cl]^{2+}$ and $[Co(NH_3)_4(H_2O)Cl]^{2+}$, the number of complex ion(s) that show(s) cis-trans isomerism is: draw their isomeric structure.	2	CO4	L5
d).	Consider the following complex ions, $[FeF_6]^{3-}$, $[V(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$. Calculate the correct order of the complex ions, according to their spin-only magnetic moment values (in B.M.)	2		
e).	Explain the spectrochemical series of CFT. Write the factors that affect the magnitude of crystal field splitting (Δ_o). Correlate the magnitude Δ_o and pairing energy (P) with respect to taking an example of d^4 and d^7 electronic configurations.	5	CO5	L4
f).	Illustrate Warner's theory and explain the structure, formation and nature of bonding in the coordination compounds with suitable examples on the basis of Warner's theory.	5		

3. a).	By using appropriate examples, discuss and illustrate the stereochemical implications of S_N1 & S_N2 reactions.	3	CO2	L3
b).	What is Markovnikov's Rule? Explain the reaction below with proper justification.  	2	CO3	L4
c).	Write the synthesis and reaction mechanism of any one of the commonly used drug molecules.	2		
d).	Write the products (A and B) and mention the name of the reaction involved, with detailed reaction conditions.  	3		
e).	Write the major product of the following reaction with a proper mechanism, if applicable.  	10	CO4	L5

NATIONAL INSTITUTE OF TECHNOLGY PATNA

Department of Computer Science & Engineering

END SEMESTER EXAMINATION, JAN-JUNE 2025

B. Tech. Mechatronics Engineering — Semester-II

Course Name: Problem Solving using C — Course Code: CS211102

Maximum Time: 3 hours — Max. Marks: 60

Instruction:

1. Attempt all questions
2. Assume any suitable data, if necessary
3. The Marks, CO (Course Outcome) and BL (Bloom's Level) related to questions are mentioned on the right-hand side margin

		Questions	Marks	CO	BL

Q1	(i)	**Write the output of the following code**
		#include <stdio.h>
		struct st{
		int i;
		char c[10];
		};
		int st = 10;
		void main() {
		struct st x;
		x.i = 10;
		printf("%d %d\n", x.i, st);
		}
			15 (1.5*10)	CO1-CO7	Analysis and Apply

	(ii)	union x { char ch; int i; double j; } U1;			

	(iii)	What will be the output of the program ?
		void main() {
		union var {
		int a, b;
		};
		union var v;
		v.a=10;
		v.b=20;
		printf("%d\n", v.a);
		}			

(iv)	What will be the output of the program ?
	#include <stdio.h>
	struct {
	int a;
	int b;
	} w = { 2, 3 };
	int main(){
	printf("%d %d", w.a, w.b);
	return 0;
	}

(v)	What will be the output of the program ?
	#include <stdio.h>
	struct {
	int a, b;
	};
	struct st = { 20, 30 };
	void main() {
	printf("%d %d", st.a, st.b);
	}

(vi)	What will be the output of the program ?
	#include <stdio.h>
	int main()
	{ int i = 10;
	void *p = &i;
	printf("%d\n", *(int)p);
	return 0;
	}

(vii)	What will be the output of the program ?
	#include <stdio.h>
	void main()
	{ int *ptr, a = 10;
	ptr = &a;
	*ptr += 1;
	printf("%d \n %d", *ptr, a);
	}

(viii) What will be the output of the program ?

```
#include <stdio.h>
  int main()
  { const  int *ptr, a = 10;
    ptr = &a;
    *ptr += 1;
    printf("%d \n %d", *ptr, a);
    return 0;
}
```

(ix) Write syntax of the String function used to compare two strings.

(x) What would be the equivalent pointer expression for referring the array element a[i][j][k][l]

(i) ((((a-i)+j)+k)+l)
(ii) *(*(*(*(a+i)+j)+k)+l)
(iii) (((a-i)-j)+k+l)
(iv) ((a-i)+j+k+l)

Q2	Write the output of the following program Assume **<stdio.h>** is included in all program	15 (1.5*10)	CO1-CO7	Analysis and Apply

(i)

```
void main()
  {  static int x;
     if (x++ < 2)
       { printf("%d\n", x);
         main();
       }
  }
```

(ii)

```
void function() {
   int i = 2;
   switch(i) {
      case 1: printf("1 ");
      case 2: printf("2 ");
      case 3: printf("3 ");
      default: printf("Not Correct Choice");
   } }
void main() {
   function();}
```


(iii)

```
void function() {
     int x = printf("Mechatronics");
     printf(" %d", x);
  }
void main() {
       function();
}
```

(iv)

```
#include <stdbool.h>
void main() {
   int i = 0;
   bool b = 1;
   for (i; b; i++ ){
      printf("NITP");
   }
}
```

(v)

(vi)

```
#include <stdbool.h>
void main()
{  int i = 0;
   for (i)
      printf("NITP");
}
```

```
void main()
{   int a = 0, i = 0, b;
    for (i = 0;i < 5; i++)
    {   continue;
        a++;
        if (i==3)
          break;
    }
    printf("%d", a);
}
```

(vii)

```
void main()
{ int i = 0, j = 0;
  for (i = 0;i < 5; i++)
  {
    for (j = 0;j < 4; j++)
    {
      if (i > 1)
        break;
    }
    printf("NITP \n");
  }
}
```

(viii)

```
1.  void main()
2.  {  int i = 0;
3.     for (i = 0;i < 5; i++)
4.        if (i < 4)
5.        {
6.           printf("NITP");
7.           break;
8.        }
9.  }
```

(ix)

```
void main()
{
  int a = 10;
  printf("%d\n", sizeof(++a));
  printf("%d", a);
}
```

(x)

```
void main()
{
  int a=0, b=2, c=3, d;
  d = a++ | b++ | c++ ;
  printf("%d", d);
}
```


Q3	(a) Explain the steps involved in Problem Solving with an example. (b) Draw the flow chart for computing the factorial of N	10 (5+5)	CO1, CO2	Remember and Understand
Q4	(a) Discuss the role of preprocessor and compiler in C programming (b) Discuss the merits of Structure and Union	10 (5+5)	CO7	Remember and Understand
Q5	Write a C program to incorporate following set of actions: (i) Open text file "Mechatronics_C Programming.txt" (ii) Write "Hello Students" and Close the File (iii) Again open the same file and write message "Welcome to C Programming Lab" in the new line (iv) Copy the content of "Mechatronics_C Programming.txt" into new file "New Programming File.txt"	10	CO8	Apply

NATIONAL INSTITUTE OF TECHNOLOGY PATNA
DEPARTMENT OF ELECTRICAL ENGINEERING
End Semester Examination, Session: Jan-June 2025

Program: B. Tech. | **Semester:** 2
Department: Mechatronics and Automation Engineering (MAE)
Course Code: EE211106
Full Marks: 60
Course Name: Electrical Workshop
Duration of Examination: 3 hours
Date: 30th April 2025

Important Instruction: • Answer all questions • Each question must be answered at one place only

Q. No.	Questions	Marks
1.	Draw symbols for the following electrical and electronic components: (i) frequency meter (ii) galvanometer (iii) electric clock (iv) speaker (v) transformer (vi) piezoelectric crystal (vii) dc current source (viii) 2P6T (two pole six throw) switch (ix) TPST (two pole single throw) switch (x) fuse.	10
2.	Describe five common electrical hazards in an electrical workshop. How can these hazards be mitigated through safe work practices?	10
3.	Explain functions of starter and ballast in a fluorescent lamp with suitable waveforms.	10
4.	With a neat diagram explain construction and working of PMMC type instruments. Write its advantages and disadvantages.	10
5.	With a neat diagram explain gravity control method for generating controlling torque.	5
6.	Design a universal shunt meter with ranges of 1 mA, 50 mA, 10 mA, 50 mA, 1A with DC ammeter of internal resistance of 200Ω and full scale current of $200\mu A$.	5
7.	A (0 to 10) Ammeter has a guaranteed accuracy of 2% of FSD. The limiting error while measuring 5 A is?	5
8.	Three resister has the following readings $R1 = 40\Omega \pm 2\%$, $R2 = 100\Omega \pm 5\%$, $R3 = 150\Omega \pm 3\%$. The limiting error in Ω or % of these resistances connected in series is?	5

* * *