CBCS SCHEME

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18MAT31

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Transform Calculus, Fourier Series and Numerical Techniques

Time: 3 hrs. Max. Marks: 100

Note: *Answer any FIVE full questions, choosing ONE full question from each module.*

Module-1

1 a. Find the Laplace transform of $\cos t \cos 2t \cos 3t$. **(06 Marks)**

b. If $f(t) = \begin{cases} t, & 0 < t < a \\ 2a - t, & a < t < 2a \end{cases}$ and $f(t + 2a) = f(t)$, show that $L\{f(t)\} = \frac{1}{s^2} \tan h \left(\frac{as}{2}\right)$. **(07 Marks)**

c. Find the Inverse Laplace transforms of :

i) $\frac{2s+1}{s^2+6s+13}$ ii) $\frac{1}{3}\log\left(\frac{s^2+b^2}{s^2+a^2}\right)$. **(07 Marks)**

OR

2 a. Express the function f(t) in terms of unit step function and find its Laplace transform, where

$$f(t) = \begin{cases} 1, & 0 < t \le 1 \\ t, & 1 < t \le 2 \\ t^2, & t > 2 \end{cases}.$$ **(06 Marks)**

b. Find the Inverse Laplace transform of $\frac{s^2}{(s^2+a^2)^2}$ using Convolution theorem. **(07 Marks)**

c. Solve by the method of Laplace transforms, the equation $y'' + 4y' + 3y = e^{-t}$ given $y(0) = 0$, $y'(0) = 0$. **(07 Marks)**

Module-2

3 a. Obtain the Fourier series of the function $f(x) = x^2$ in $-\pi \le x \le \pi$. **(06 Marks)**

b. Obtain the Fourier series expansion of

$$f(x) = \begin{cases} x, & 0 < x < \pi \\ x - 2\pi, & \pi < x < 2\pi \end{cases}.$$ **(07 Marks)**

c. Find the Cosine half range series for $f(x) = x(\ell - x)$, $0 \le x \le \ell$. **(07 Marks)**

OR

4 a. Obtain the Fourier series of $f(x) = |x|$ in $(-\ell, \ell)$. **(06 Marks)**

b. Find the sine half range series for

$$f(x) = \begin{cases} x, & 0 < x < \pi/2 \\ \pi - \pi, & \pi/2 < x < \pi \end{cases}.$$ **(07 Marks)**

c. Obtain the constant term and the coefficients of the first cosine and sine terms in the Fourier expansion of y from the table. **(07 Marks)**

x	0	1	2	3	4	5
y	9	18	24	28	26	20

Module-3

5 a. If $f(x) = \begin{cases} 1-x^2 & , |x|<1 \\ 0 & , |x| \geq 1 \end{cases}$. Find the Fourier transform of f(x) and hence find value of $\int_0^\infty \frac{x\cos x - \sin x}{x^3} dx$. **(06 Marks)**

b. Find the Fourier Cosine transform of
$$f(x) = \begin{cases} 4x, & 0<x<1 \\ 4-x, & 1<x<4 \\ 0, & x>4 \end{cases}$$ **(07 Marks)**

c. Find the Z – transform of $\cos\left(\frac{n\pi}{2}+\frac{\pi}{4}\right)$. **(07 Marks)**

OR

6 a. Solve the Integral equation
$\int_0^\infty f(\theta)\cos\alpha\,\theta\, d\theta = \begin{cases} 1-\alpha & , 0 \leq \alpha \leq 1 \\ 0 & , \alpha > 1 \end{cases}$ hence evaluate $\int_0^\infty \frac{\sin^2 t}{t^2} dt$. **(06 Marks)**

b. Find the Inverse Z – transform of $\frac{2z^2+3z}{(z+2)(z-4)}$. **(07 Marks)**

c. Using the Z – transform, solve $Y_{n+2} - 4Y_n = 0$, given $Y_0 = 0$, $Y_1 = 2$. **(07 Marks)**

Module-4

7 a. Using Taylor's series method, solve the Initial value problem $\frac{dy}{dx} = x^2y - 1$, $y(0) = 1$ at the point x = 0.1. Consider upto 4^{th} degree term. **(06 Marks)**

b. Use modified Euler's method to compute y(0.1), given that $\frac{dy}{dx} = x^2 + y$, $y(0) = 1$ by taking h = 0.05. Consider two approximations in each step. **(07 Marks)**

c. Given that $\frac{dy}{dx} = x - y^2$, find y at x = 0.8 with

x :	0	0.2	0.4	0.6
y :	0	0.02	0.0795	0.1762

By applying Milne's method. Apply corrector formula once. **(07 Marks)**

OR

8 a. Solve the following by Modified Euler's method $\frac{dy}{dx} = x + |\sqrt{y}|$, $y(0) = 1$ at x = 0.4 by taking h = 0.2. Consider two modifications in each step. **(06 Marks)**

b. Given $\frac{dy}{dx} = 3x + \frac{y}{2}$, y(0) = 1. Compute y(0.2) by taking h = 0.2 using Runge – Kutta method of order IV. **(07 Marks)**

c. Given $\frac{dy}{dx} = (1+y)x^2$ and y(1) = 1, y(1.1) = 1.233, y(1.2) = 1.548, y(1.3) = 1.979, determine y(1.4) by Adam's Bashforth method. Apply corrector formula once. **(07 Marks)**

Module-5

9 a. Given $y'' - xy' - y = 0$ with $y(0) = 1$, $y'(0) = 0$. Compute $y(0.2)$ using Runge – Kutta method. **(06 Marks)**

b. Derive Euler's equation in the form $\frac{\partial f}{\partial y} - \frac{d}{dx}\left(\frac{\partial f}{\partial y'}\right) = 0$. **(07 Marks)**

c. Prove that the geodesics on a plane are straight lines. **(07 Marks)**

OR

10 a. Find the curve on which functional $\int_0^1 [(y')^2 + 12xy]dx$ with $y(0) = 0$, $y(1) = 1$ can be extremized. **(06 Marks)**

b. Obtain the solution of the equation $\frac{2d^2y}{dx^2} = 4x + \frac{dy}{dx}$ by computing the value of dependent variable corresponding to the value 1.4 of the independent variable by applying Milne's method using the following data. Apply corrector formula once. **(07 Marks)**

x :	1	1.1	1.2	1.3
y :	2	2.2156	2.4649	2.7514
y' :	2	2.3178	2.6725	3.0657

c. A heavy cable hangs freely under gravity between two fixed points. Show that the shape of the cable is Catenary $y = c \cosh\left(\frac{x+a}{c}\right)$. **(07 Marks)**

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CBCS SCHEME

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Third Semester B.E. Degree Examination, July/August 2021
Mechanics of Materials

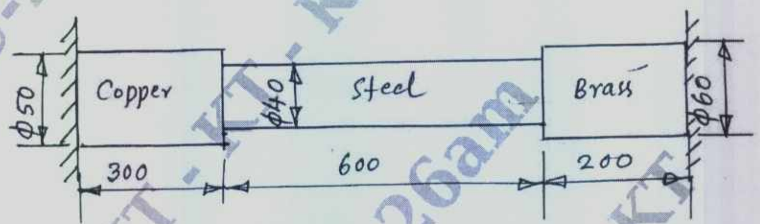
Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions.

1 a. Define the terms : (i) Modulus of rigidity (ii) Factor of safety (iii) True stress (iv) Volumetric strain **(04 Marks)**

b. Deduce expression to determine the elongation of tapered rectangular bar of uniform thickness. **(06 Marks)**

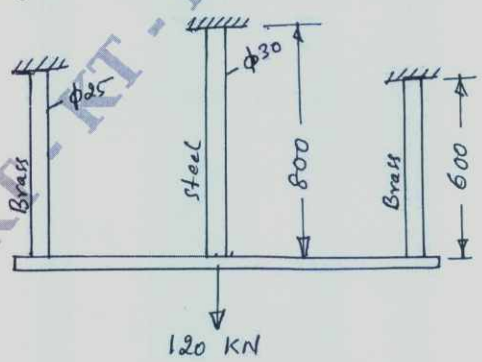
c. A composite bar made of copper, steel and brass is rigidly attached to the end supports as shown in Fig. Q1 (c). Determine the stresses in the three portions of the bar when the temperature of the composite system is raised by 70°C, considering that the supports are rigid. Take $E_C = 100\,\text{GPa}$, $E_S = 205\,\text{GPa}$, $E_b = 95\,\text{GPa}$, $\alpha_C = 18\times10^{-6}/^\circ\text{C}$, $\alpha_S = 11\times10^{-6}/^\circ\text{C}$, $\alpha_b = 19\times10^{-6}/^\circ\text{C}$. **(10 Marks)**



All dimensions are in mm
Fig. Q1 (c)

2 a. Define Bulk modulus. Derive a relationship between Young's modulus, modulus of rigidity and Poisson's ratio. **(10 Marks)**

b. Three equally spaced rods in the same vertical plane support a rigid bar AB. Two outer rods are of brass, each 600 mm long and of 25 mm in diameter. The central rod is of steel that is 800 mm long and 30 mm in diameter. Determine the forces in the rods due to an applied load of 120 kN through the mid point of the bar. The bar remains horizontal after the application of load. Take $\frac{E_S}{E_b} = 2$. The rigid bar system is shown in Fig. Q2 (b). **(10 Marks)**



Dimensions are in mm
Fig. Q2 (b)

3 a. Define Principal plane. Deduce expressions for stresses on an inclined plane in a body subjected to bi-axial stress condition. **(10 Marks)**

b. A thick cylinder has inner and outer diameters as 120 mm and 180 mm respectively. It is subjected to an external pressure of 9 MPa. Find the value of internal pressure which can be applied if the maximum stress is not to exceed 30 MPa. Draw the curves showing the variation of hoop and radial stresses through the material of the cylinder. **(10 Marks)**

4 a. What assumptions are taken in the analysis of thin cylinders? Deduce expressions for the circumferential and longitudinal stresses developed in thin cylinder. **(10 Marks)**

b. A plane element is subjected to stresses as shown in Fig. Q4 (b). Draw the Mohr's circle and determine principal stresses, maximum shear stress and their planes. **(10 Marks)**

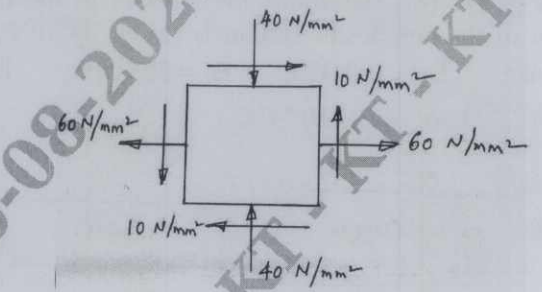


Fig. Q4 (b)

5 a. Draw the shear force and bending moment diagrams for a Cantilever subjected to forces as shown in Fig. Q5(a). **(10 Marks)**

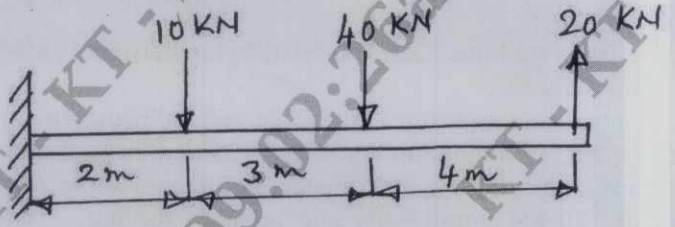


Fig. Q5 (a)

b. Prove the relation $\frac{\sigma_y}{y} = \frac{M}{I} = \frac{E}{R}$ for simple bending. **(10 Marks)**

6 a. A 10 m long simply supported beam is loaded as shown in Fig. Q6 (a). Draw the shear force and bending moment diagrams. **(10 Marks)**

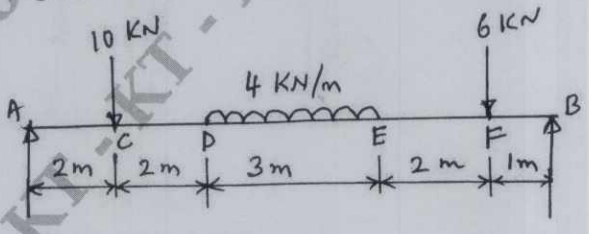


Fig. Q6 (a)

b. A 200 mm × 80 mm I-beam is to be used as a simply supported beam of 6.75 m span. The web thickness is 6 mm and the flanges are of 10 mm thickness. Determine what concentrated load can be carried at a distance of 2.25 m from one support if the maximum permissible stress is 80 MPa. **(10 Marks)**

7 a. A bolt is acted upon by an axial pull of 16 kN along with a transverse shear force of 10 kN. Determine the diameter of the bolt required according to (i) Maximum principal stress theory (ii) Maximum shear stress theory. **(10 Marks)**

b. Deduce the torsion equation with usual notations, stating the assumptions made. **(10 Marks)**

8 a. A shaft transmits 280 kW of power at 160 rpm. Determine

(i) The diameter of solid shaft to transmit the required power.

(ii) The inner and outer diameters of a hollow circular shaft if the ratio of the inner to the outer diameter is $\frac{2}{3}$.

(iii) The percentage saving in the material on using a hollow shaft instead of a solid shaft.

Take the allowable stress as 80 MPa and the density of the material 78 kN/m^3. **(10 Marks)**

b. A thin walled 800 mm long member has the cross section as shown in Fig. Q8 (b). Determine

(i) The maximum torque if the angle carried by the section is limited to 4°.

(ii) The maximum shear stress induced for the maximum torque.

Take G = 82 GPa. **(10 Marks)**

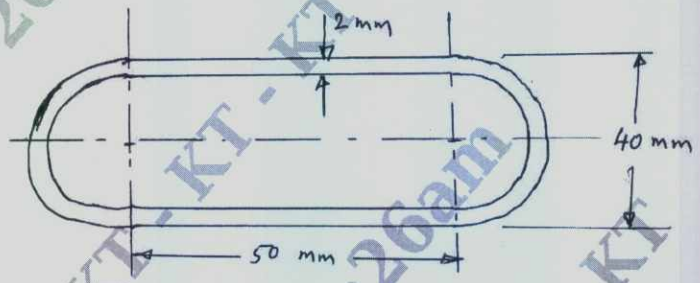


Fig. Q8 (b)

9 a. Derive an expression for Euler's critical load for a column with both ends hinged. **(10 Marks)**

b. A 4-m long hollow alloy tube with inside and outside diameters as 36 mm and 48 mm elongates by 3 mm under a tensile force of 50 kN. Determine the buckling load for the tube when it is used as a column with both ends pinned (hinged) and a factor of safety of 5. **(10 Marks)**

10 a. Derive an expression for strain energy for a member subjected to axial load. **(05 Marks)**

b. Explain Castigliano's theorem – I. **(05 Marks)**

c. Two elastic bars of equal length and of the same material ; one is of circular cross section of 80 mm diameter and the other of square cross section of 80 mm side. Both absorb the same amount of strain energy under axial forces. Compare the stresses in the two bars. **(10 Marks)**

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CBCS SCHEME

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18ME33

Third Semester B.E. Degree Examination, July/August 2021
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note : 1. ***Answer any FIVE full questions.***
2. ***Use of thermodynamic data handbook and steam table is permitted.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Explain Mechanical , Chemical and Thermal equilibrium. **(06 Marks)**

b. With suitable examples, distinguish between : i) Open and closed system ii) Point and path function iii) Intensive and Extensive property. **(06 Marks)**

c. A constant volume gas thermometer, contain helium gives a reading of gas pressure 'P' of 1000 and 1366 mm of Hg at ice and steam point respectively. Assuming a linear relationship of form $T = a + bP$. Express the gas thermometer celicious temperature 'T' in terms of gas pressure 'P'. What is temperature recorded when thermometer reads 1074 mm of Hg. **(08 Marks)**

2 a. What do you understand by Microscopic and Macroscopic approach? **(06 Marks)**

b. Define i) State ii) Process iii) System iv) Quasistatic process. **(08 Marks)**

c. Define Zeroth law of thermodynamics and briefly explain its significance. **(06 Marks)**

3 a. Define Heat and Work in thermodynamics. Show that work is path function. **(08 Marks)**

b. Derive an expression for work done during an adiabatic process. **(06 Marks)**

c. A quasistatic process occurs such that $P = V^2 + \frac{8}{V}$, where 'P' is pressure in bar and V is volume in m^3. Find the work done when volume changes from $1m^3$ to $3m^3$. **(06 Marks)**

4 a. State the First law of thermodynamics applied to cyclic and non cyclic process. **(04 Marks)**

b. Derive Steady flow energy equation with Assumptions. **(06 Marks)**

c. Steam enters a turbine with a velocity of 320 m/s , Pressure 6 bar, Internal energy 2000 kJ/kg Specific volume of 0.36 m^3/kg and leaves at a velocity of 140 m/s , Pressure of 1.2 bar , Internal energy 1400 kJ/kg , Specific volume $1.3m^3$/kg. If the flow rate of fluid is 220kg/min and fluid rejects 100 kJ/s of heat. Determine the power developed in MW. The change in potential energy is neglected. **(10 Marks)**

5 a. Write two statements of Second law of thermodynamics and show their equivalence. **(10 Marks)**

b. A reversible engine 'A' operates between temperature limits T_1 and T_2 [$T_1 > T_2$]. The heat rejected by engine 'A' is received by another reversible engine 'B'. Engine 'B' rejects the heat to reservoir at temperature 'T_3' [$T_2 > T_3$].

Prove that i) $T_2 = \frac{T_1 + T_3}{2}$ for same work output ii) $T_2 = \sqrt{T_1 T_3}$ for same efficiency. **(10 Marks)**

6 a. Show that the entropy is a property of a system. **(06 Marks)**

b. State and prove Clausius inequality. **(06 Marks)**

c. 5 kg copper block at 200^0C is dipped to an insulated tank with 100kg of oil at 30^0C. Find the increase in entropy of the universe.
Take C_p [copper] = 0.4kJ/kg – K , C_p [oil] = 2.1 kJ/kg-K. **(08 Marks)**

7 a. What is Available and Unavailable energy? **(06 Marks)**
b. Write Maxwell relations and explain the terms involved. **(06 Marks)**
c. Derive Clausius Clayperon equation for evaporation of liquid and explain the significance. **(08 Marks)**

8 a. Define the following terms with reference to the pure substance : i) Latent heat ii) Sensible heat iii) Tripple point iv) Wet steam v) Dryness fraction. **(10 Marks)**
b. With neat sketch, explain the working of Separating Throttling Calorimeter. **(10 Marks)**

9 a. Explain the following :
i) Compressibility factor.
ii) Compressibility chart.
iii) Vander Waals equation of state.
iv) Law of corresponding states.
v) Gibbs Dalton's law. **(10 Marks)**
b. One K – mol of methane is stored in a $0.4m^3$ tank at 300K. Estimate the pressure of the gas using i) Ideal gas equation ii) Vander Waal's equation.
Vander Waal's constant $a = 228.5$ KPa $(m^3/K\text{-mol})^2$.
$b = 0.0427\ m^3/K\text{-mol}$. **(10 Marks)**

10 a. Derive Vander Waal's constants in terms of critical properties. **(08 Marks)**
b. A gaseous mixture has the following volumetric analysis. $O_2 = 30\%$, $CO_2 = 40\%$, $N_2 = 30\%$. Determine i) Analysis on mass basis.
ii) Molecular weight of mixture.
iii) Partial pressure of each component if total pressure is 100KPa and temperature is 32^0C. **(12 Marks)**

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18ME34

Third Semester B.E. Degree Examination, July/August 2021
Material Science

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

1 a. Define Atomic Packing Factor. Calculate APF for Face Cubic Centre (FCC) unit cell. **(08 Marks)**

b. Explain briefly points, line and surface defects, with neat sketches. **(12 Marks)**

2 a. With the help of stress – strain diagram, briefly explain the ductile and brittle behavior of Engineering Materials. **(10 Marks)**

b. Explain slip and twinning, with neat sketches. **(10 Marks)**

3 a. List different types of fatigue loading with examples. **(04 Marks)**

b. Explain with a neat sketch, the different stages of creep. **(08 Marks)**

c. What is meant by Stress Relaxation? Derive an expression for the stress relaxation. **(08 Marks)**

4 a. Construct and label the Iron – Carbon equilibrium diagram and explain briefly. **(10 Marks)**

b. What is Nucleation? Explain homogeneous nucleation in solidification. **(10 Marks)**

5 a. Explain the steps to construct TTT diagram. Draw a labeled sketch of TTT diagram for an eutectoid steel. **(10 Marks)**

b. Explain the following : i) Annealing ii) Normalizing. **(10 Marks)**

6 a. Explain the following : i) Pack carburizing ii) Flame hardening. **(10 Marks)**

b. Briefly explain Microstructure of Grey Cast Iron and SG Iron. Mention the composition , properties and applications of each. **(10 Marks)**

7 a. Explain the process of preparation of MMC using Melting and Casting method (Stir Casting method). **(10 Marks)**

b. Explain the following with neat sketches :
i) Hand layup process ii) Spray process. **(10 Marks)**

8 a. Explain with a neat sketch, the Sheet – Moulding Compound (SMC) process of producing composites. **(08 Marks)**

b. What are the Applications of Composites? **(04 Marks)**

c. Calculate the tensile modulus of elasticity of unidirectional Carbon – fiber reinforced Composite Material which contains 62% by volume of carbon fibers in Iso – strain and Iso – stress condition.
E_{carbon} fibers = 3.86×10^4 kg/mm^2 and $E_{epoxy} = 4.28 \times 10^2$ kg/mm^2. **(08 Marks)**

9 a. Make use of different processing methods for the manufacturing of thermoplastics and explain the following : i) Hydrostatic extrusion ii) Slip casting. **(10 Marks)**

b. Explain the following with neat sketches : i) Calendering ii) Blow moulding. **(10 Marks)**

10 a. Write a note on Piezoelectric materials. **(06 Marks)**

b. List and explain the Biological applications of smart materials. **(06 Marks)**

c. Explain briefly few common NDT methods used for the testing of materials. **(08 Marks)**

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CBCS SCHEME

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18ME35A/MEA305

Third Semester B.E. Degree Examination, July/August 2021
Metal Cutting and Forming

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

1	a.	Sketch and explain Tool signature of Single point cutting tool.	**(07 Marks)**
	b.	Determine the Shear Plane angle of Single Point cutting tool.	**(10 Marks)**
	c.	What are the types of chips?	**(03 Marks)**
2	a.	Sketch and explain the parts of an Engine Lathe.	**(10 Marks)**
	b.	What are the Lathe Operations?	**(05 Marks)**
	c.	Differentiate between Engine Lathe and Capstan and Turret Lathe.	**(05 Marks)**
3	a.	Sketch and brief about the various Milling Operations.	**(10 Marks)**
	b.	What are the methods of Indexing?	**(05 Marks)**
	c.	Note the differences between drilling , boring and reaming operations.	**(05 Marks)**
4	a.	What are the differences between Shaper, Planar and Slotter?	**(08 Marks)**
	b.	Sketch and explain Surface Grinding machine.	**(12 Marks)**
5	a.	What are the effect of Process Parameters on tool life? Explain.	**(10 Marks)**
	b.	What are the functions of cutting fluids?	**(05 Marks)**
	c.	What are the effect of Machining Parameters on Surface finish.	**(05 Marks)**
6	a.	What is Machinability and Machinability Index? Explain.	**(08 Marks)**
	b.	The following equation for tool life is given for a turning operation ($VT^{(0.13)}.f^{(0.77)}.d^{(0.37)} = C$). A 60min tool life was obtained while cutting at V = 30m/min , f = 0.3mm/rev and depth of mt d = 25mm. Calculate the change in tool life, if the cutting speed , feed , depth of cut are increased by 25%, Individaully and also taken together. What will be their effect on tool life?	**(12 Marks)**
7	a.	Sketch and explain different forging equipments.	**(12 Marks)**
	b.	Write a note on different forging defects.	**(08 Marks)**
8	a.	Sketch and explain the types of Rolling Mills.	**(12 Marks)**
	b.	What are the variables in drawing process?	**(08 Marks)**
9	a.	Sketch and explain Sheet Metal Cutting Operation.	**(12 Marks)**
	b.	Brief out the different variables in drawing process.	**(08 Marks)**
10	a.	Explain : i) Drawing Ratio ii) Thickness Ratio iii) Drawing Force iv) Blank holding force v) Ironing.	**(10 Marks)**
	b.	Explain with neat sketches, Progressive and Combination dies.	**(10 Marks)**

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CBCS SCHEME

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18MATDIP31

Third Semester B.E. Degree Examination, July/August 2021
Additional Mathematics – I

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions.

1 a. Show that $(1+\cos\theta+i\sin\theta)^n+(1+\cos\theta-i\sin\theta)^n = 2^{n+1}\cos^n\left(\frac{\theta}{2}\right)\cos\left(\frac{n\theta}{2}\right)$. **(07 Marks)**

b. Express $1-i\sqrt{3}$ in polar form and hence find its modulus and amplitude. **(06 Marks)**

c. Express $\frac{1}{1-\cos\theta+i\sin\theta}$ in the form a + ib and also find its conjugate. **(07 Marks)**

2 a. Define dot product between two vectors A and B. Find the sine of the angle between the vectors $\vec{A}=2\hat{i}-2\hat{j}+\hat{k}$ and $\vec{B}=\hat{i}-2\hat{j}+2\hat{k}$. **(07 Marks)**

b. If $\vec{A}=\hat{i}-2\hat{j}+3\hat{k}$, $\vec{B}=-\hat{i}+2\hat{j}+\hat{k}$ and $\vec{C}=3\hat{i}+\hat{j}$, find the value of p such that $\vec{A}-p\vec{B}$ is perpendicular to $\vec{C}$. **(06 Marks)**

c. Find $\vec{a}\cdot(\vec{b}\times\vec{c})$, $\vec{b}\times(\vec{a}\times\vec{c})$ and $\vec{c}\cdot(\vec{a}\times\vec{b})$ where $\vec{a}=\hat{i}+\hat{j}-\hat{k}$, $\vec{b}=2\hat{i}-\hat{j}+2\hat{k}$, $\vec{c}=3\hat{i}-\hat{j}-\hat{k}$. **(07 Marks)**

3 a. Obtain the Maclaurin's series expansion of log(sec x) upto the terms containing x^6. **(07 Marks)**

b. If $u=\tan^{-1}\left(\frac{x^3+y^3}{x-y}\right)$ then using Euler's theorem, prove that $x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}=\sin 2u$. **(06 Marks)**

c. If u = f(x – y, y – z, z – x), prove that $\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}+\frac{\partial u}{\partial z}=0$. **(07 Marks)**

4 a. Obtain the Maclaurin's series expansion of the function $\sqrt{1+\sin 2x}$ upto x^4. **(07 Marks)**

b. If $u=e^{\frac{x^2y^2}{x+y}}$, prove that $x\frac{\partial u}{\partial x}+y\frac{\partial u}{\partial y}=3u\log u$ using Euler's theorem. **(06 Marks)**

c. If $u=\frac{yz}{x}$, $v=\frac{zx}{y}$, $w=\frac{xy}{z}$ then show that $\frac{\partial(u,v,w)}{\partial(x,y,z)}=4$ **(07 Marks)**

5 a. A particle moves along a curve $x = 3t^2$, $y = t^3 - 4t$, $z = 3t + 4$ where t is the time variable. Determine the components of velocity and acceleration vectors at t = 2 in the direction $\hat{i}-2\hat{j}+2\hat{k}$. **(07 Marks)**

b. Find the unit normal vector to the surface $xy^3z^2 = 4$ at the point (–1, –1, 2). **(06 Marks)**

c. Show that the vector field $\vec{F}=(2x+yz)\hat{i}+(4y+zx)\hat{j}-(6z-xy)\hat{k}$ is irrotational. Also find ϕ such that $\vec{F}=\nabla\phi$. **(07 Marks)**

6 a. Find div $\vec{F}$ and Curl $\vec{F}$, where $\vec{F} = \nabla(x^3 + y^3 + z^3 - 3xyz)$. **(07 Marks)**

b. If $\vec{F} = (3x^2y - z)\hat{i} + (xz^3 + y^4)\hat{j} - 2x^3z^2\hat{k}$ then find $\nabla \cdot \vec{F}$, $\nabla \times \vec{F}$ and $\nabla \cdot (\nabla \times \vec{F})$ at (2, −1, 0). **(06 Marks)**

c. Determine the constant 'a' such that the vector $(2x + 3y)\hat{i} + (ay - 3z)\hat{j} + (6x - 12z)\hat{k}$ is Solenoidal. **(07 Marks)**

7 a. Obtain a reduction formula for $\int_0^{\pi/2} \cos^n x dx (n > 0)$. **(07 Marks)**

b. Evaluate $\int_0^a x^4 \sqrt{a^2 - x^2} dx$. **(06 Marks)**

c. Evaluate $\int_1^5 \int_1^{x^2} x(x^2 + y^2) dx dy$. **(07 Marks)**

8 a. Obtain a reduction formula for $\int_0^{\pi/2} \sin^n x dx \ (n > 0)$. **(07 Marks)**

b. Evaluate $\int_0^{2a} x^2 \sqrt{2ax - x^2} dx$ **(06 Marks)**

c. Evaluate $\int_{-1}^{1} \int_{0}^{z} \int_{x-z}^{x+z} (x + y + z) dy dx dz$ **(07 Marks)**

9 a. Solve $(2x^3 - xy^2 - 2y + 3)dx - (x^2y + 2x)dy = 0$ **(07 Marks)**

b. Solve $\frac{dy}{dx} - y \tan x = y^2 \sec x$. **(06 Marks)**

c. Solve $3x(x + y^2)dy + (x^3 - 3xy - 2y^3)dx = 0$ **(07 Marks)**

10 a. Solve $\frac{dy}{dx} + y \cot x = \sin x$. **(07 Marks)**

b. Solve $(x + 3y - 4)dx + (3x + 9y - 2)dy = 0$ **(06 Marks)**

c. Solve $[1 + (x + y)\tan y]\frac{dy}{dx} + 1 = 0$ **(07 Marks)**

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