Code No: R19BS1101 **R19** SET - 1

I B. Tech I Semester Regular Examinations, January - 2020
MATHEMATICS-I
(Com. to CE,EEE,ME,ECE,CSE,Chem E, EIE,IT,Auto E,Min E,Pet E, Agri E)

Time: 3 hours Max. Marks: 75

Answer any five Questions one Question from Each Unit
All Questions carry Equal Marks

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1. a) Test the convergence of the series $\sum \sqrt[3]{(n^3+1)} - n$ (8M)

   b) If x > 0 show that $x > \log(1+x) > x - \frac{x^2}{2}$ (7M)

Or

2. a) Test the convergence of the series $\sum \frac{1^2.4^2.7^2.....}{3^2.6^2.9^2...}$ (8M)

   b) If f (x) = e^x and g(x) = e^{-x} in [a , b] then show that c is the average of a and b using Cauchy's mean value theorem. (7M)

3. a) Solve the D.E $r \sin\theta \, d\theta + (r^3 - 2r^2\cos\theta + \cos\theta)\, dr = 0$ (8M)

   b) If the population of a country doubles in 50 years, in how many years will it triple, assuming that the rate of increase is proportional to the number of in habitants? (7M)

Or

4. a) Solve the D.E $y(x^2y^2+2)dx + x(2-2x^2y^2)dy = 0$ (8M)

   b) Solve the electrical circuit equation given by $L\frac{di}{dt} + iR = E\cos wt$ with i(0) =0 . (7M)

5. a) Determine the charge on the capacitor at any time t > 0 in circuit in series having an EMF E(t) = 100 sin 60 t, a resistor of 2 ohms, an inductor of 0.1 henries and capacitor of $\frac{1}{260}$ farads, if the initial current and charge on the capacitor are both zero. (8M)

   b) Solve the D.E $(D^2+1)\, y = \sin x \sin 2x + e^x x^2$ (7M)

Or

6. a) Solve the D.E $(D^2 + 3D + 2)\, y = xe^x \sin x$ (8M)

   b) Solve the D.E $(D^3 - 3D^2 + 4D - 2)\, y = e^x + \cos x + x$ (7M)

7. a) If u = lx+my , v = mx-ly then show that (8M)

   $(i) \left(\frac{\partial u}{\partial x}\right)\left(\frac{\partial x}{\partial u}\right) = \frac{l^2}{l^2+m^2}$ $(ii) \left(\frac{\partial u}{\partial y}\right)\left(\frac{\partial y}{\partial u}\right) = \frac{l^2+m^2}{l^2}$

   b) If the sum of three variables is a constant, then find the numbers when the product of three numbers is maximum. (7M)

Or
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8. a) Expand $\tan^{-1}\left(\frac{y}{x}\right)$ in powers of (x-1)(y-1) up to third degree and hence evaluate f(1.1,0.9) (8M)

b) Find maximum of $x^m y^n z^p$ given that $x+y+z=a$. Using Lagrange' multiplier method. (7M)

9. a) Evaluate $\int\int (x^2+y^2)\,dx\,dy$ over the area bounded by the Ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (8M)

b) Evaluate $\int_0^{\pi/2}\int_0^{a\sin\theta}\int_0^{(a^2-r^2)/a} r\,dr\,d\theta\,dz$ (7M)

Or

10. a) Evaluate $\iiint_V xyz\,dx\,dy\,dz$ where v is bounded by the co-ordinate planes and the plane $x+y+z=1$. (8M)

b) Find the area Enclosed by the pair of curves $y=4x-x^2$, $y=x$. (7M)

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1. a) Test the convergence of the series $\sum\left(\frac{nx}{n+1}\right)^n$ (8M)

   b) Test the convergence of the series $\frac{1}{6}-\frac{2}{11}+\frac{3}{16}-\frac{4}{21}+\ldots$ (7M)

Or

2. a) Test the convergence of the series $\sum\frac{4.7\ldots(3n+1)}{1.2.3\ldots n}x^n$ (8M)

   b) Verify Rolle's mean value theorem for $f(x)=\log\left(\frac{x^2+ab}{(a+b)x}\right)$ in [a,b] where a > b > 0 (7M)

3. a) Solve the D.E $y^4\ dx=\left(x^{\frac{-3}{4}}-y^3x\right)dy=0$ (8M)

   b) A resistance of 100 ohms an inductance of 0.5 henry are connected in series with a battery of 20 volts. Find the current in the circuit as a function of t, if initially there is no current in the circuit. (7M)

Or

4. a) Solve the D.E $(r+\sin\theta-\cos\theta)dr+r(\sin\theta+\cos\theta)d\theta=0$ (7M)

   b) Show that the family of curves $\frac{x^2}{a^2+\lambda}+\frac{y^2}{b^2+\lambda}=1$ is self-orthogonal, where λ is a parameter. (8M)

5. a) Solve the D.E $\left(D^2+1\right)y=x^2\sin 2x$ (8M)

   b) Determine the current i(t) in an L – C – R circuit with E.M.F E(t) = E_0 sin wt in case the circuit is tuned to resonance so that $w^2=\frac{1}{Lc}$ and $\frac{R}{L}$ is so small and assuming that q(0) = i(0)=0. (7M)

Or

6. a) Solve the D.E $\left(D^2-4\right)y=x\sinh x+54x+8$ (7M)

   b) Solve the D.E $(D^2+4)y=4\tan 2x$ by the method of Variation of parameters. (8M)
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7. a) If $u = r^n(3\cos^2\theta - 1)$ then prove that $\frac{\partial}{\partial r}\left[r^2\frac{\partial u}{\partial r}\right] + \frac{1}{\sin\theta}\frac{\partial}{\partial\theta}\left[\sin\theta\frac{\partial u}{\partial\theta}\right] = 0$ (8M)

b) Find the extreme values of $\sin x \sin y \sin(x+y)$ (7M)

Or

8. a) Expand $e^x \cos y$ near $(1, \pi/4)$ (7M)

b) If $x = r\cos\theta$, $y = r\sin\theta$, Evaluate $J = \frac{\partial(x,y)}{\partial(r,\theta)}$ and $J^1 = \frac{\partial(r,\theta)}{\partial(x,y)}$ (8M)

9. a) Evaluate $\iint r^3\, dr\, d\theta$ over the area included between the circles r = 2 sinθ and r = 4 sin θ. (8M)

b) Find the volume under the paraboliod $x^2 + y^2 + z = 16$ over rectangle $x = \pm a$, $y = \pm b$ using triple integral. (7M)

Or

10. a) By change of Integration Evaluate $\int_o^1 \int_{x^2}^{x} xy\, dx\, dy$ (7M)

b) Evaluate $\iiint_V (x+y+z)\, dx\, dy\, dz$ taken over the volume bounded by $x = 0$, $x = 1$, $y = 0$, $y = 1$ and $z = 0$, $z = 1$. (8M)

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1. a) Test the convergence of the series $\sum\sqrt{\left(n^4+1\right)-\left(n^4-1\right)}$ (8M)

   b) Verify the Lagrange's mean value theorem for $f(x)=x(x-1)(x-2)$ in [0 , 0.5] (7M)

Or

2. a) Test the convergence of the series $x+\frac{2^2x^2}{2!}+\frac{3^3x^3}{3!}+......$ (8M)

   b) Test the convergence of the series $\sum\frac{(-1)^{n-1}}{\sqrt{n(n+1)(n+2)}}$ (7M)

3. a) Solve the D.E $\left(1+x^2\right)\frac{dy}{dx}-2xy=2x\left(1+x^2\right);\ y(0)=1$ (8M)

   b) Find the orthogonal trajectories of the confocal and coaxial parabolas $r=\frac{2a}{1+\cos\theta}$ (7M)

Or

4. a) Solve the D.E $(3xy^2-y^3)dx-(2x^2y-xy^2)dy=0$ (7M)

   b) Find the current in electrical circuit is given by $L\frac{di}{dt}+iR=E$ where E = 6 volts, R = 100 ohms, L = 0.1 henry and how long will be it before the current has reached one – half its maximum value. (8M)

5. a) Solve the D.E $\left(D^2+2D+1\right)y=x.\cos x$ (8M)

   b) $\left(D^2-3D+2\right)y=\sin\left(e^{-x}\right)$ (7M)

Or

6. a) Solve the D.E $\frac{d^2y}{dx^2}-7\frac{dy}{dx}+6y=e^{2x}(1+x)$ (7M)

   b) Solve the D.E $y^{11}-2y^1+y=e^x\log x$ by the method of Method of Variation of parameters. (8M)
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7. a) If $u = \tan^{-1}\left(\frac{x^3+y^3}{x-y}\right)$ then find $x^2\frac{\partial^2 u}{\partial x^2}+2xy\frac{\partial^2 u}{\partial x\partial y}+y^2\frac{\partial^2 u}{\partial y^2}$ using Euler's theorem. (8M)

b) Find the extreme values of $2\left(x^2-y^2\right)-x^4+y^4$ (7M)

Or

8. a) If $u = f(x^2+2yz, y^2+2zx)$ prove that (8M)

$$(y^2-zx)\frac{\partial u}{\partial x}+(x^2-yz)\frac{\partial u}{\partial y}+(z^2-xy)\frac{\partial u}{\partial z}=0$$

b) If u = x+y+z , uv = y+z , uvw = z then find $J\left(\frac{x,y,z}{u,v,w}\right)$ (7M)

9. a) Evaluate $\int_0^2\int_0^{\sqrt{2x-x^2}}(x^2+y^2)\,dx\,dy$ by changing in to polar co-ordinates. (7M)

b) Evaluate $\iiint_V dx\,dy\,dz$ where v is the volume bounded by the planes $x = 0$, $y = 0$, $z =$ 0, $z = 1$ and the cylinder $x^2 + y^2 = 1$ (8M)

Or

10. a) By change of order of integration evaluate $\int_0^a\int_x^a (x^2+y^2)\,dx\,dy$ (7M)

b) Evaluate $\iiint_v dv$, , where v is the Region that lies below the plane $z = x + 2$, above xy plane and between the cylinder $x^2 + y^2 = 1$ and $x^2 + y^2 = 4$. (8M)

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1. a) Test the convergence of the series $\frac{2}{3}x+\frac{3^2x^2}{4^2}+\frac{4^3x^3}{5^3}+......$ (7M)

   b) If $0<a<b$, then prove that $\frac{b-a}{1+b^2}<\tan^{-1}(b)-\tan^{-1}(a)<\frac{b-a}{1+a^2}$ (8M)

Or

2. a) Test the convergence of the series $x-\frac{x^2}{4}+\frac{x^3}{9}-\frac{x^4}{16}+......$ (7M)

   b) Expand $Tan^{-1}(x)$ about origin. (8M)

3. a) Solve the D.E $[\cos x\tan y+\cos(x+y)]dx+[\sin x.\sec^2 y+\cos(x+y)]dy=0$ (7M)

   b) If the temperature of the air is 30^0C and the substance cools from 100^0C to 70^0C in 15 minutes, find when the temperature will be 40^0C. (8M)

Or

4. a) Solve the D.E $\left(y+\frac{x^2}{2}+\frac{y^3}{3}\right)dx+\frac{1}{4}(x+xy^2)dy=0$ (8M)

   b) A voltage Ee^{-at} is applied at t = 0 to a circuit containing inductance L and resistance R. Then find the current $i(t)$ at any time. (7M)

5. a) Solve the D.E $(D^2+4)y=x\sin x$ (8M)

   b) A particle of mass 4 gm executing simple harmonic motion has velocities 8 cm/sec and 6 cm/sec respectively. When it is at distance 3 cm and 4 cm from the centre of its path. Find its period and amplitude. Find also the force acting on the particle when it is a distance 1cm from the centre. (7M)

Or

6. a) Solve the D.E $(D^3-5D^2+7D-3)y=e^{2x}\cosh x$ (7M)

   b) Solve the D.E $(D^2-1)y=e^{-x}\sin(e^{-x})+\cos(e^{-x})$ by the method of Method of Variation of parameters. (8M)
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7. a) If $u=\left(x^2+y^2\right)^{\frac{1}{3}}$ then find $x^2\frac{\partial^2 u}{\partial x^2}+2xy\frac{\partial^2 u}{\partial x\partial y}+y^2\frac{\partial^2 u}{\partial y^2}$ using Euler's theorem. (7M)

b) Prove that the functions u $=x^2e^{-y}\cosh z$, v = $x^2e^{-y}\sinh z$ and w = $3x^4e^{-2y}$ are functionally dependent and hence find the relation between them. (8M)

Or

8. a) If $u=f(r,s),\ r=x+y, s=x-y$ show that $\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}=2\frac{\partial u}{\partial r}$ (7M)

b) Find the minimum value of $x+y+z$ subject to $\frac{a}{x}+\frac{b}{y}+\frac{c}{z}=1$ using Lagrange's multiplier method. (8M)

9. a) Evaluate $\int_0^\infty\int_0^\infty \frac{dx\,dy}{(x^2+y^2+a^2)^2}$ using polar co-ordinates. (7M)

b) Find the volume of region bounded by the surface $z = x^2 + y^2$ and $z = 2x$. Using triple integral. (8M)

Or

10. a) Find using double Integral the volume bounded by cylinder $x^2 + y^2 = 4$ the plane $y + z = 3;\ z = 0$. (7M)

b) Evaluate $\int_{-1}^{1}\int_{0}^{\sqrt{1-y^2}}\int_{x^2+y^2}^{\sqrt{x^2+y^2}} dx\,dy\,dz$ (8M)