KATHMANDU UNIVERSITY
End Semester Examination
August/September, 2017

Marks scored:

Level : B.Sc.
Year : II

Course : MATH 217
Semester: II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date : SEP 13 2017

SECTION "A"

[10 Q. × 1= 10 marks]

Fill in the blank space(s) by writing the most appropriate word(s) or symbol(s).

1. The order of the PDE $u_t = u_{yy}$ is _____.

2. A solution of a differential equation which cannot be derived from the general solution but still is a solution of the given differential equation is called a(n) = _____.

3. The Wronskian of the functions x^2 and $x|x|$ is _____.

4. The general solution $u(x, y)$ of the PDE $u_y = u$ is _____.

5. If $(x_1(t), y_1(t))$ and $(x_2(t), y_2(t))$ be any two solutions of a homogeneous systems $x'(t) = a_1x(t) + b_1y(t)$ and $y'(t) = a_2x(t) + b_2y(t)$, then their Wronskian is _____.

6. The solution of the nonlinear differential equation $p^2 - 2p + 1 = 0$, $p = \frac{dy}{dx}$ is _____, where c is an integration constant.

7. The model equation for the current $I(t)$ in a closed loop of an RL-circuit with voltage $E(t)$ is given by _____.

8. If $J_\gamma(x)$ and $Y_\gamma(x)$ be respectively the Bessel polynomial of first kind and second kind, then the general solution of the Bessel equation $x^2y'' + xy' + (x^2 - \gamma^2)y = 0$ is given by $y(x)$ = _____ where A and B are arbitrary constants.

9. The unit step function is defined by $u(t-a) = \begin{cases} 1, & t > a \\ 0, & t < a \end{cases}$. The representation of the function $f(t) = \begin{cases} 1, & 0 \le t < 1 \\ 0, & t > 1 \end{cases}$ in terms of unit step function is given by $f(t)$ = _____.

10. The general solution to the Euler-Cauchy differential equation $x^2y'' + 2xy' - 12y = 0$, $x \neq 0$ is $y(x)$ = _____, where A and B are arbitrary constants.

SECTION "B"

[10 Q. × 1 = 10 marks]

Fill in the blank space(s) by selecting the most appropriate answer from among the given ones. (*Do not tick the answer*).

11. The differential equation $y''+y^2=0$ is _____.
[linear and homogeneous, linear and non-homogeneous,
nonlinear and homogeneous, nonlinear and non-homogeneous]

12. The solution of the differential equation $9yy'+4x=0$ is a family of _____.
[circle, hyperbola, ellipse, parabola]

13. The integrating factor of the non-exact differential equation $\frac{dy}{dx}+p(x)y=q(x)$ is _____.
[$\int p(x)dx$, $\int q(x)dx$, $e^{\int p(x)dx}$, $e^{\int q(x)dx}$]

14. The PDE $yu_{xx}+u_{yy}=0$ is hyperbolic if _____.
[$y<0$, $y=0$, $y>0$, $|y|<1$]

15. The root of the characteristic equation of the homogeneous system $x'(t)=-2y(t),\ y'(t)=\frac{1}{2}x(t)$ is _____.
[-1, 0, 1, $-i$]

16. In the mass spring balance model equation $m\frac{d^2x}{dt^2}+c\frac{dx}{dt}+k\,x(t)=f(t)$, the constant c is called _____.
[spring constant, damping constant, restoring force, external force]

17. A differential equation of the form $y=px+f(p)$, where $p=\frac{dy}{dx}$ is known as _____ equation.
[Euler, Cauchy, Lagrange, Clairaut]

18. If $L\{f(t)\}=F(s)$, then $L\left\{\int_0^t f(u)du\right\}=$ _____, where L is the Laplace transform operator.
[$sF(s)$, $\frac{F(s)}{s}$, $s^2F(s)$, $\frac{F(s)}{s^2}$]

19. The Legendre's polynomial $P_2(x)=$ _____.
[$\frac{1}{2}(3x^2-1)$, $\frac{1}{2}(x^2-3)$, $\frac{1}{2}(1-3x^2)$, $\frac{1}{2}(3-x^2)$]

20. The equation $u_{xx}+u_{yy}=f(x,y)$ is a _____ equation.
[heat, wave, Laplace, Poisson]

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SECTION "C"
[3 Q. × 7 = 21 marks]

1. Find the solution $u(x,y)$ of the Laplace equation $u_{xx}+u_{yy}=0$ in the rectangular region $R: 0<x<a, 0<y<b$ subjected to the boundary conditions $u(0,y)=0, \quad u(a,y)=0$
$u(x,0)=0, \quad u(x,b)=f(x)$. [3 + 4]

OR

Find the solution $u(x,t)$ of the 1D wave equation $u_{tt}=u_{xx}$, $0<x<L, t>0$ using d'Alembert's method satisfying the initial conditions $u(x,0)=f(x), \quad u_t(x,0)=0$ and boundary conditions $u(0,t)=0, \quad u(L,t)=0$ for all t. [4 + 3]

2. Discuss the method of determinant to find the solution of the homogeneous system
$$x'(t)=a_{11}x(t)+a_{12}y(t)$$
$$y'(t)=a_{21}x(t)+a_{22}y(t)$$
Use this method to solve the homogeneous system
$x'(t)=4x(t)-2y(t), \; y'(t)=5x(t)+2y(t)$. [3 + 4]

3. Define Wronskian of two functions $y_1(x)$ and $y_2(x)$. If functions $y_1(x)$ and $y_2(x)$ be any two linearly dependent solutions of the differential equation $y''+a(x)y'+b(x)y=0$ then show that their Wronskian is zero. Also, find any two linearly independent solutions of $y''-8y'+16y=0$, and then find its general solution. [1 + 2 + 4]

SECTION "D"
[6 Q. × 4 = 24 marks]

4. Show that $\frac{d}{dx}\left[x^{\gamma}J_{\lambda}(x)\right]=x^{\gamma}J_{\gamma-1}(x)$, where the symbols have their usual meanings.

OR

Use Rodrigue formula to derive the expression for the Legendre's polynomial $P_4(x)$.

5. If a resistance of 2000 ohms and a capacitance of 5×10^{-6} farad are connected in series with an emf of 100 volts, what is the current at $t=0.1$ second if $I(0)=0.01$ ampere?

6. Solve $xp^2+(y-x)p-y=0$ where $p=\frac{dy}{dx}$.

7. When the air temperature is 70^0 F, an object cools from 170^0 F to 140^0 in 0.5 hour. What is the temperature after 1 hour?

8. Find the solution of the differential equation $(x+y+1)\frac{dy}{dx}=1$.

9. . Solve $y''+y=\cos x,\ y(0)=3,\ y'(0)=0$.

SECTION "E"

[5 Q. × 2 = 10 marks]

10. Solve the PDE $x^2u_{xx}+2xu_x-2u=0$ treating as ODE.

11. Use Power series method to find the general solution $y(x)$ of $y'=2y$.

12. Find the solution of $x^2y''+3xy'+y=0$

13. Verify that $y=a\cos x+b\sin x$ is the solution of $y''+y=0$, where a and b are arbitrary constants.

14. Is the differential equation $\left(x^3+3xy^2\right)dx+\left(3x^2y+y^3\right)dy=0$ exact?

Mark Scored:

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SECTION "A"
[20Q ×0.5 = 10 marks]

Tick the correct answers.

1. Fluid property due to which mercury doesn't wet the glass is
   a. Viscosity b. Surface tension c. Cohesion d. Adhesion

2. The normal stress is the same in all directions at a point in a fluid when the fluid is
   a. Non-viscous b. Incompressible
   c. Both (a) and (b) d. Having no motion of fluid layer

3. Power loss in an orificemeter is _____ that in venturimeter.
   a. Less than b. Same as c. More than d. Data insufficient

4. Paper pulp is an example of _____ fluid.
   a. Newtonian b. Pseudoplastic c. Dilatent d. Bingham plastic

5. A particle 'A' of diameter 10 μm settles in an oil of specific gravity 0.9 and viscosity 10 poise under Stoke's law. A particle 'B' with diameter 20 μm settling in the same oil will have settling velocity_____
   a. Same as that of A b. ¼ of A
   c. 2A d. 4A

6. For flow through a packed bed with Reynolds number < 1.0, the pressure drop per unit length is proportional to superficial velocity and diameter of particle by
   a. V_s/D_p^2 b. V_s^2/D_p c. V_s^2/D_p^3 d. D_p/v_s^2

7. Dimension of surface tension is
   a. $ML^{-1}T^{-2}$ b. MT^{-2} c. ML^2T^{-2} d. $ML^{-1}T^{-1}$

8. A Bingham fluid of viscosity μ = 10 Pa.s and yield stress τ_0 =10 kPa, is shared between two parallel plates separated by a distance of 10^{-3} m. The top plate is moving with a velocity of 1 m/s. The shear stress on the plate is
   a. 10 kPa b. 20 kPa c. 30 kPa d. 40 kPa

9. The ratio of V_{avg} to V_{max} in case of laminar flow of a Newtonian fluid in a circular pipe is
   a. 0.5 b. 1 c. 2 d. 0.66

10. Which of the following may be termed as a variable area flow meter
    a. Venturimeter b. Orificemeter c. Rotamter d. Pitot tube

11. Vena-contracta pressure tapping is at a distance _____from the position of an orifice meter of diameter 'd' filled in a pipe.
a. d b. 0.5 d c. 2 d d. 4 d

12. For mixing or compounding of rubber and plastics, the type of mixer used is
a. Ribbon blenders b. Static mixers c. Banbury mixer d. Planetory mixer

13. For pipe flows, head is proportional to _____at constant capacity. (where D = pipe diameter)
a. 1/D b. $1/D^2$ c. $1/D^5$ d. D^2

14. A centrifugal pump has power =4 H.P; speed = 800 rpm; head =8 m and flow = 1000 l/min. If it's speed is halved, the new discharge (l/min) will be
a. 500 b. 200 c. 1000 d. 750

15. A pressure of 10 m head of water is equivalent to _____kN/m^2.
a. 98 b. 9.8 c. 49 d. 147

16. Percentage slip in reciprocating pump where Q_1 refers to actual and Q_2 refers to theoretical, is given by
a. Q_1/Q_2 b. Q_2/Q_1 c. $(Q_2 - Q_1)/Q_1$ d. $(Q_2 - Q_1)/Q_2$

17. The line traced by a single fluid particle as it moves over a period of time is called _____line.
a. Stream b. Path c. Steak d. Equipotential

18. Ratio of maximum to average velocity in case of streamline flow between parallel plates is
a. 1 b. 1.5 c. 2 d. 2.5

19. In a drag on a sphere, value of coefficient of drag 'C_d' for Reynolds Number 'NRe' 1000 -100000 is
a. 4 b. 0.5 c. 0.2 d. 24/NRe

20. Which of the following is used as unidirectional flow valve?
a. Butterfly valve b. Gate valve c. Check valve d. Glove valve