MONSOON – 2007-08

III B. TECH [MECH/ MM/ PET/ MIN/ MLE/ELECT/ENV] EXAMINATION

Subject : MECHANICS OF SOLIDS [MMC 13101] **Max. Marks : 100**

Max. Time : 3 Hours

Instructions : Answer any TWO questions from GROUP –A and ALL from GROUP –B. Assume missing data (if any) suitably. All parts of a question MUST be completed in a sequence of the question and in continuation, for full marks. Marks will be deducted otherwise.

Q. No.	Questions for GROUP – A [ANSWER ANY TWO]	Marks
1.	A rigid prismatic bar of length 3b [Fig. 1] is held to horizontal position by two tie rods: (1) –Al rod and (2)- Mg rod of length L_1 and L_2 respectively. Their respective diameters are d_1 and d_2 and Young's modulii are E_1 and E_2.	
(a)	**Find** the expression for maximum allowable load, P_{max}, at the free end, B (without causing yielding of the rods). [Preferably use flexibility method].	14
(b)	**Find** the value of P_{max}, if $L_1 = 0.4$m, $L_2 = 0.3$m, $d_1 = 4.0$mm, $d_2 = 3.0$mm, $E_1 = 72$ GPa, $E_2 = 45$ GPa, $\sigma_1\big\vert_{allow} = 200$ MPa.	6
2. (a)	**State** the assumptions associated with the determination of stresses in a thick cylinder problem.	5
(b)	**Derive** the Lame's equations for a thick cylinder analysis.	10
(c)	**Schematically draw** Lame's lines (i) to represent a solution to a general thick cylinder problem, (ii) to represent the solution when the thick cylinder is under internal and external pressure.	5
3. (a)	Evaluate and draw the S.F.D. and B.M.D. for the beam shown in [Fig. 2.a] and locate the point of contraflexure.	14
(b)	**Find** the maximum deflection for a cantilever beam [Fig. 2 (b)] whose $I_{N.A.}$ = 46.2×10^{-6} m^4 and E = 12 GPa (use formula superposition method, preferably).	6
	Questions for GROUP – B [ANSWER ALL THE QUESTIONS]	
4. (a)	The stresses on the element [in fig. 3] are $\sigma_x = 3$ MPa, $\sigma_y = 1$ MPa, τ_{xy} = 2 MPa. Find the stresses on a plane formed at 22.5^0 with left vertical axis through the element. (use formula approach).	5
(b)	For the same element **find** the principal stresses and their directions (use Mohr's circle approach).	7
5. (a)	**Establish** the relationship between the Young Modulus, E and shear modulus, G.	5
(b)	A 45^0 strain gauge rosette records the strains as $\varepsilon_0 = 350\ \mu$, $\varepsilon_{45} = 213\mu$, $\varepsilon_{90} = 250\ \mu$, $\mu = 10^{-6}$. **Determine** the 2-D strain state at that point. Also find the principal strains at that point.	7
6. (a)	Compare the maximum shear stress in a thin circular tube of mean radius r with constant wall thickness t when τ_{max} is calculated by approximate thin tube theory [of Bredt = τ_B] and τ_{max} is calculated from commonly used torsion theory [of Colomb = τ_C]. If $\frac{r}{t} = \beta$ find the values of τ_B / τ_C for β = 5,10 and 20. Note, r >> t.	8
(b)	A cantilever beam of length, L and constant strength is required to carry a concentrated load, P, at its free end. It is having a varying rectangular cross-section [Fig. 4]. **Derive** the expression for its theoretical shape neglecting the shear stresses.	4
7.	A simply supported beam has 5m span and a uniform T-section [Fig. 5] of 100 mm width and 150 mm depth with flange thickness, t_f = 25 mm, and web thickness, t_w = 12 mm. If the limiting bending stresses for the beam material are taken as 80 MPa in compression and 160 MPa in tension, **find** the maximum u.d.l. this beam can safely carry.	12
8.	A steel bar of rectangular cross-section 40 mm x 50 mm has pin-pin end condition. It is used to carry axial compressive load. If the proportional limit for the material is 230 MPa and E = 210 GPa, **determine** the minimum length for which Euler's equation can be applied to evaluate the buckling load. If the evaluated length is increased to twice the value what will be the critical load	12

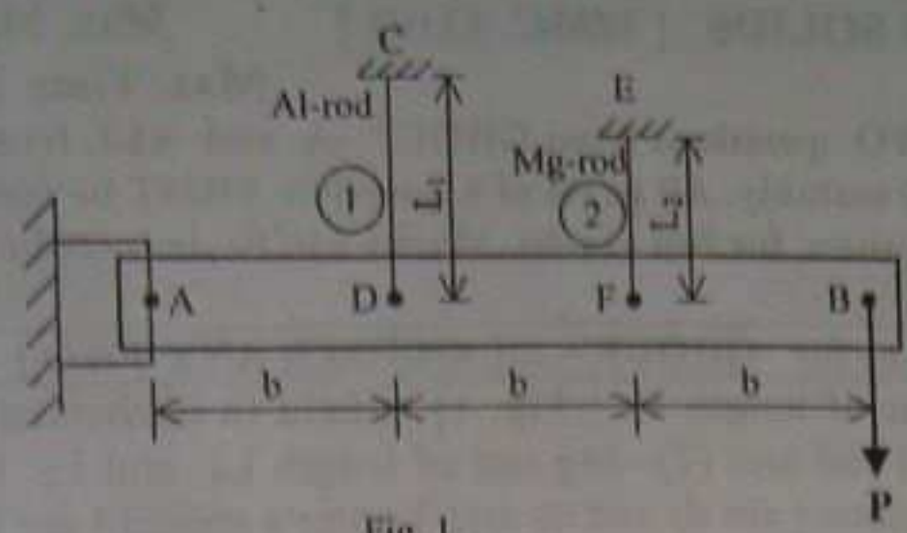

Fig. 1.

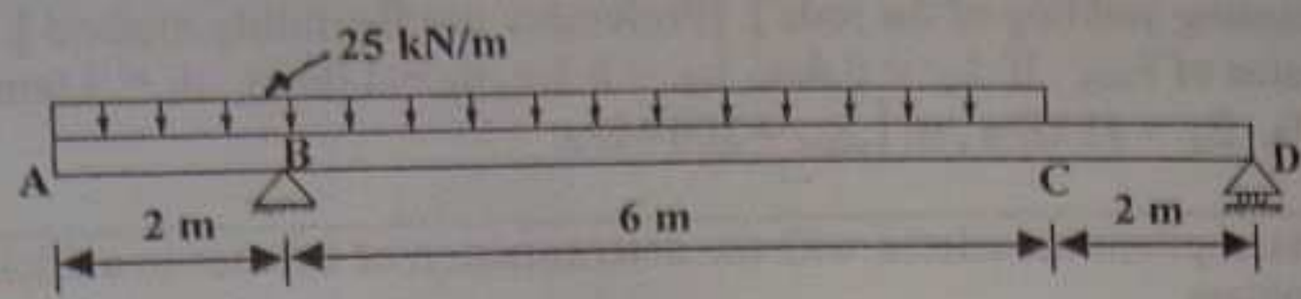

Fig. 2(a)

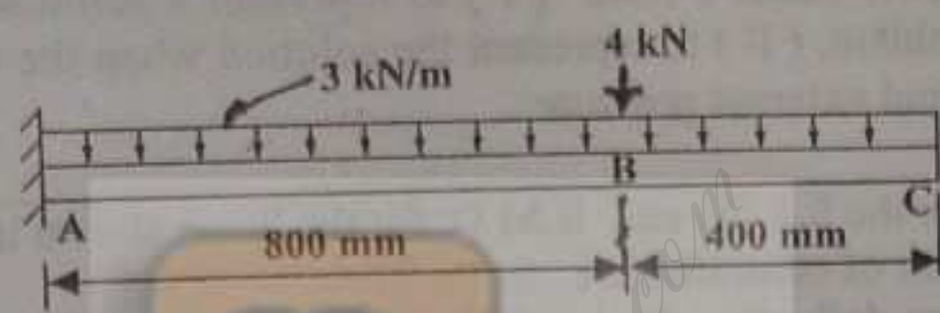

Fig. 2(b)

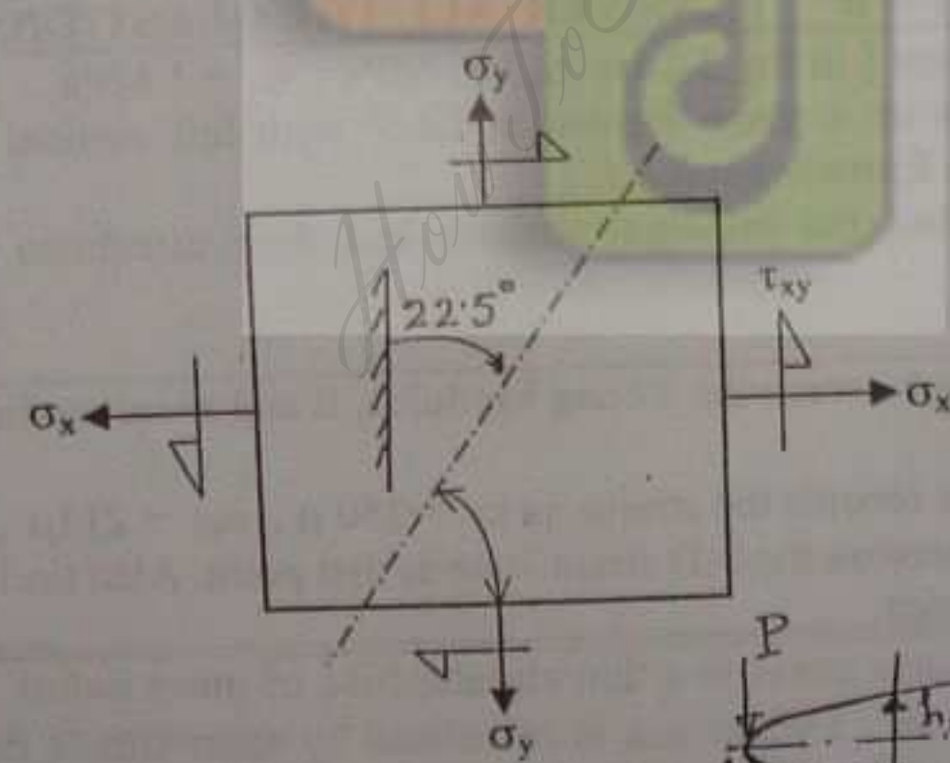

Fig. 3.

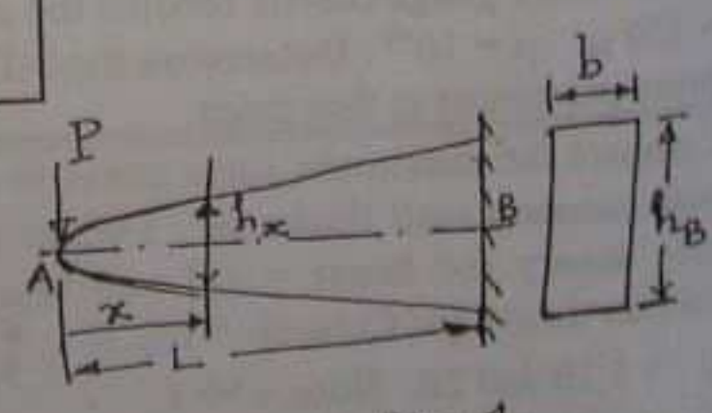

Fig. 4.

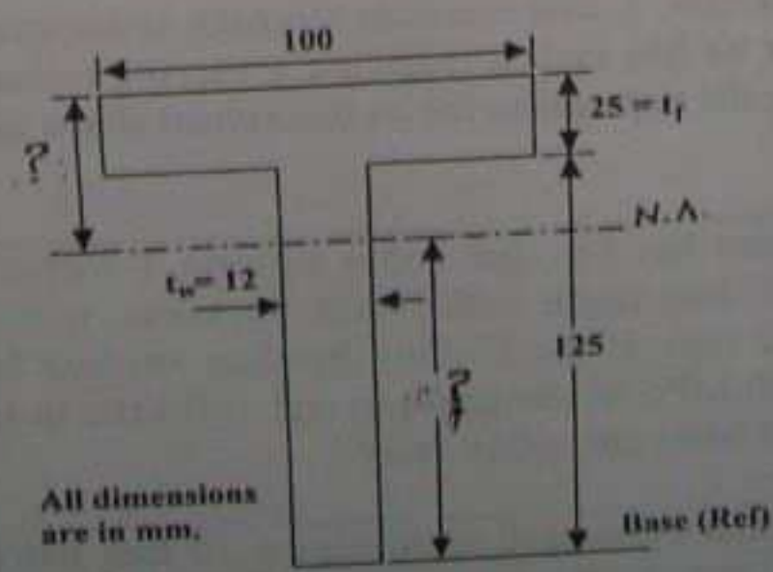

Fig. 5

(Question paper

SEMEST

Examination & Semeste

Subject (Block letters)

Instructions, if any An

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Section (if any)

Q. No	Question
1.	The crank and the c 300 RPM has turn accelera a) Veloc b) angul conn c) accel
2.	Find an shoe br The whe A rider 16 Kl/h and bic wheel. Coeffic comes cycle
3.	Draw, follow from th

SEMESTER: MONSOON **SESSION: 2007-2008**
Examination & Semester: III Sem. B. Tech. (Common) **Time: 3Hours**
Subject: MATHEMATICS- III **Max. Marks: 100**

Instructions: (i) Use separate Answer Book for each section.
(ii) Figures in the margin indicate full marks.

Section-A

(Analysis of Complex Variable: 33 marks)

Question No. 1 is compulsory. Attempt any **Two** from the rest.

Q1.(i) Show that the polar form of Cauchy–Riemann equations are

$$\frac{\partial u}{\partial r}=\frac{1}{r}\frac{\partial v}{\partial \theta}, \frac{\partial v}{\partial r}=-\frac{1}{r}\frac{\partial u}{\partial \theta}$$ (5)

(ii) Evaluate $\int_c \frac{zdz}{(z-1)(z-2)^2}, c:|z-2|=1/2$ (4)

(iii) Find the bilinear transformation which maps 1, i, -1 to 2, i, -2 respectively. Also find the fixed point of the transformation. (5)

(iv) Find the Laurent's expansion of $f(z)=\frac{7z-2}{(z+1)z(z-2)}$ in the region $1<|z+1|<3$ (5)

Q2. Evaluate $\int_0^\infty \frac{\cos x dx}{x^2+a^2}$, using Contour integration. (7)

Q3. Evaluate $\int_C \frac{e^z dz}{(z^2+\pi^2)^2}$, where C is the circle $|z|=4$. (7)

Q4. If f (z) = u + i v is an analytic function of z = x + i y and ψ any function of x and y with differentiable coefficient of first and second order derivatives then prove that

$$\left(\frac{\partial \psi}{\partial x}\right)^2+\left(\frac{\partial \psi}{\partial y}\right)^2=\left\{\left(\frac{\partial \psi}{\partial u}\right)^2+\left(\frac{\partial \psi}{\partial v}\right)^2\right\}|f'(z)|^2$$ (7)

Section B (33 Marks)

(Special functions)

Q. Nos. 1 to 4 are compulsory. Attempt any TWO from the rest.

1. Express $I=\int_0^{\pi/2}\frac{dx}{\sqrt{\cos x}}$ in terms of an elliptic integral (5)

2. Prove that
$\int J_3(x)dx = C - J_2(x) - \frac{2}{x}J_1(x)$, C is a constant of integration. (4)

3. Prove that
$$\int_{-1}^{1}(1-x^2)[P_n'(x)]^2 dx=\frac{2n(n+1)}{2n+1}.$$ (5)

4. Prove that
$2n\, J_n(x) = x\,[J_{n-1}(x) + J_{n+1}(x)]$. (5)

5. Using Frobenius method solve the equation
$xy'' + y' + xy = 0$. (7)

6. Show that
$$J_n(x)=\frac{1}{\pi}\int_0^\pi \cos(n\phi - x\sin\phi)d\phi$$, n being an integer. (7)

7. (i) Expand f(x) = 0, $-1<x<0$
= 1, $0<x<1$
in terms of Legendre polynomials upto the degree 3. (5)
(ii) Prove that
$$P_{2m}(0)=(-1)^m\frac{1.3.5.....(2m-1)}{2.4.6.....(2m)}.$$ (2)

SECTION: C

(Laplace Transform and P.D.E: 34 MARKS)

Question Nos. 1 to 3 are compulsory. Attempt any Two from the rest.

Q. No.	Questions	Marks
1.	Let $F(t)=\begin{cases}3t, 0<t<2\\ 6, 2<t<4\end{cases}$ where F(t) is periodic function with period T = 4. Find the laplace transform of F(t).	(6)
2.	Find the inverse laplace transform of $\dfrac{1}{(s-1)^3(s+2)}$	(6)
3.	Using Laplace transform technique solve $$tY''+2Y'+tY=0,\quad Y(0)=1,\quad Y(\pi)=0$$	(6)
4.	Using Laplace transform technique solve $$\frac{\partial U}{\partial t}=3\frac{\partial^2 U}{\partial x^2},\ U_x(0,t)=0,\ U(\frac{\pi}{2},t)=0$$ if $U(x,0)=20\cos 3x-5\cos 9x$	(8)
5.	A square plate is bounded by the lines x=0, y=0, x=20 and y = 20. Its faces are insulated. The temperature along the upper horizontal edge is given by $u(x,20)=x(20-x)$ *when* $0<x<20$, while the other edges are kept at 0^0C. Using variable separable method find the steady state temperature at any point on the plate.	(8)
6.	A tightly stretched string with fixed end points x=0and x=l is initially at rest into its equilibrium position. If it is vibrating by giving to each of its points a velocity x(l-x), find the displacement of the string at any distance x from one end at any time t by method of separation of variables.	(8)

SEMESTER: MONSOON: SESSION: 2007-2008

Examination & Semester: B.Tech. III (Electrical, Environmental, Mechanical, Mining, Mining Machinery Engineering)

Time: 3 Hours Subject: APPLIED THERMODYNAMICS (MMC 13102) Max. Marks: 100

Instructions:

1. Attempt any **TWO** questions from Group A (Q.1-3) and **ALL** questions from Group B (Q.4-8).
2. Assume missing data, suitably, if any.
3. Notations have their usual meanings, unless stated otherwise.
4. Use of Steam Table is permitted.

GROUP – A (Answer any two questions)

1. It is well established that the adiabatic and reversible volume change of an ideal gas (R, c_v) in a cylinder and piston apparatus follows the path $PV^{\gamma} = \text{constant}$, where $\gamma = \frac{c_p}{c_v}$. Real processes, however, depart from this path; the actual path is named polytropic and is represented by the function $PV^{n} = \text{constant}$, where n is a constant $(n \neq \gamma)$. The mass of the ideal gas is m, the mass of the cylinder wall is M, and the specific heat of the wall material is c. At any instant during the expansion or compression process, the ideal gas and the wall material are in mutual thermal equilibrium. Furthermore, the combined system (ideal gas and the wall material) does not exchange heat with its surroundings. The expansion or compression process is sufficiently slow so that $|\delta W| = |PdV|$ is practically valid.

   (a) Show that the path of the polytropic process is designated by $n = 1 + \frac{R/c_v}{1 + Mc/mc_v}$. — 5

   (b) How large or small should the wall heat capacity be if the path is to approach $PV^{\gamma} = \text{constant}$? — 5

   (c) Evaluate the entropy change dS for the combined system during the infinitesimal change in volume from V to $(V + dV)$. — 5

   (d) Invoke the Second Law of Thermodynamics to decide whether the process executed by the combined system is reversible or irreversible? — 5

2. Steam at a pressure of 15 bar and 250° C expands according to the law $PV^{1.25} = \text{constant}$ to a pressure 1.5 bar. Sketch the process path in a convenient plane and find the (a) final conditions, (b) work done, (c) heat transfer and, (d) entropy change. The mass of the steam is 0.9 kg. — 5 5 5 5

3. In a Rankine cycle, the steam at inlet to turbine is dry saturated at a pressure of 30 bar and exhaust pressure is 0.24 bar. Sketch the process path on to a suitable plane and determine (a) the pump work, (b) turbine power, (c) Rankine efficiency, and (d) the condenser heat flow? Assume a flow rate of 10 kg/s. — 5 5 5 5

GROUP – B (Answer all questions)

4. (a) According to Newton's Second Law of Motion, the resultant of all forces is equal to the time rate of change in the momentum of the system. Projecting this statement in one direction of interest x, we have $\sum_{in} \dot{m}V_x - \sum_{out} \dot{m}V_x + \sum F_x = \frac{\partial}{\partial t}(MV_x)_{cv}$. In similarity with this equation cast the First Law of Thermodynamics as an energy conservation equation for an open system. Therefrom write down an expression for the First Law of Thermodynamics reduced for a closed system.

(b) The work and heat exchange involved by a system in a process A are 20 kJ and 16 kJ respectively. Another process B between the same final conditions involves a heat input of 9 kJ. Determine the change in internal energy involved and also the work done during the process B. Prove that if a cycle is formed employing process A and B, the First Law of Thermodynamics is obeyed.

5. (a) Define COP of a heat pump and refrigerator. Hence argue that COP of a heat pump is always greater than that of a refrigerator.

(b) In a cascaded system, cycles are coupled in series such that the heat rejected by the topping cycles are employed by the bottoming cycles. Assuming the efficiency of the *ith* cycle to be η_i arrive at an expression for the overall efficiency η of the combined cycle consisting of n cycles as $\eta = 1 - \prod_{i=1}^{n}(1-\eta_i)$. Taking a numerical example for two cycles with $\eta_1 = 0.25$ and $\eta_2 = 0.30$ show that there remains a true gain in overall efficiency.

6. (a) A closed system type gas turbine power plant is operating on Brayton cycle. Derive an expression for thermal efficiency involving pressure ratio as a parameter. Also show that the optimum pressure ratio for maximum work output is square root of maximum permissible pressure ratio.

(b) Considering air to be the working fluid with $c_p/c_v = 1.4$, and normally encountered temperatures in gas turbine to be 288 K and 1000 K plot (not to scale) the variation of thermal efficiency and net work output with respect to the variation of pressure. ratio.

7. (a) Sketch various process paths on to the $P-V$ plane separately for Otto cycle, Diesel cycle and Dual cycle. From the efficiency expression of Dual cycle deduce the efficiency expressions for Otto and Diesel cycle as corollaries.

(b) An air standard dual cycle has a compression ratio of 16, and compression begins at 1 bar and 50° C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate the pressures and temperatures at all other cardinal points of the cycle. Thus calculate the air standard thermal efficiency of the cycle. Assume $c_v = 0.718$ kJ/kgK and $c_p = 1.005$ kJ/kgK for air.

8. (a) Define thermal efficiency and equivalent evaporation of a boiler.

(b) 5400 kg of steam is produced per hour at a pressure of 740 kN/m^2 in a boiler feeded with water at 41° C. The dryness fraction of steam at the exit is 0.98. The amount of coal burnt per hour is 670 kg. The calorific value of coal is 31000 kJ/kg. Determine the boiler thermal efficiency and equivalent evaporation.

INDIAN SCHOOL OF MINES UNIVERSITY
Department of Mining Engineering

Examination: III Semester B.Tech. (ME) (Combined course) — Session: 2007-08
Semester: Monsoon Semester — Time: 3 Hours
Subject: **Exploration Drilling and Rock Breaking (MEC 13101)** — Marks: 100

Q.No.	Question	Marks

Section – A
Attempt any **two** questions

1. Explain the importance of geology in open cast blast design. Design a blast for coal measure rock strata having 14m bench height, average compressive strength 80 MPa, hole diameter 165 mm. (assume other parameters – like type of excavator etc.) (20)

2. (a) What do you understand by wire line drilling? State its merits over other methods of core drilling (10)

   (b) With the help of a sketch explain the hydraulic feed mechanism used in diamond core drilling. (10)

3. Briefly discuss the rock properties that affect drilling. What do you understand by dirllability of rocks? Discuss various parameters to be considered while selecting a drill rig. (20)

Section – B
All questions are compulsory

4. What do you understand by permitted explosives? How are these different from other explosives? Why P1 cannot be used in Degree II gassy coal mines? (10)

5. Discuss the different types of augers used in drilling with their suitability. (10)

6. Discuss the blasting techniques used in Bord and Pillar workings in coal mines. (10)

7. What do you understand by cap sensitive explosives? Explain with the help of sketches a delay detonator. (10)

8. Compare between the following: (5)
   (a) Emulsion and NG-based explosives (5)
   (b) Down the hole drilling and Top hammer drilling (5)
   (c) Diagonal and v-pattern of firing (5)
   (d) Button bit and tri-cone rock roller bit

Examination: III B.Tech Mining Engineering — Session: 2007-2008 Monsoon Semester

Time: 3 hrs — Marks: 100

Subject: Geology I (Physical Geology and Structural Geology)

Answer any two questions from Part -I and all questions from Part-II

PART-I

Q. No		Marks
1	Define different elements of a fold. Describe the geometrical classification of folds.	20
2	What are the tectonic divisions of India? Describe the characteristic features of peninsular India..	20
3	What is Nebular theory? Give a brief account about interior of the earth.	20

PART- II

4	How joints are different from faults? Describe the classification of joints in relation to deformation.	15
5	Give a brief account on geological works of rivers.	15
6	Write short notes on any three of the following: (a) Plate boundaries. (b) Physical and chemical weathering. (c) Double star hypothesis (d) Nonconformity and disconformity	(3X5)=15
7	Attempt any three of the following: (a) What is rock Cleavage? (b) What is Barchan? (c) Define Oasis (d) Determine the strike and dip of an oil bearing strata on the basis of exploratory drilling data pairs The apparent dip values are as follows:	(3X5)=15

Amount of Apparent dip	Direction of Apparent dip
36 degree	N80 E
47degree	N60 W