W'11:5 AN:MN 405 (1534)

MINING MACHINERY AND MATERIAL HANDLING

Time : Three hours

Maximum Marks : 100

Answer FIVE *questions, taking* ANY TWO *from* **Group A,** ANY TWO *from* **Group B** and ALL *from* **Group C.**

All parts of a question (a, b, etc.) should be answered at one place.

Answer should be brief and to-the-point and be supplemented with neat sketches. Unnecessary long answers may result in loss of marks.

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Group A

1. (*a*) Explain the operating mechanism of a Lily controller with the help of a neat sketch. 10

   (*b*) Explain, with illustrations, the following : 5 + 5

   (*i*) Reliance rope capel
   (*ii*) King type safety hook

2. (*a*) Explain, with illustrations, various types of armoured flexible chain conveyor based on the type of chain strands. Answer should include their various merits and demerits. 8

(*Turn Over*)

(*b*) What is a stage loader and state its purpose ? Explain, with illustration, the closed bottom pan, ramp plate, spill plate, cable trough attached with the AFC. Enumerate the following : (*i*) Special features of armoured face conveyor to be used for the longwall faces ; and (*ii*) main requirement of AFC chain. 12

3. (*a*) Describe various types of winding ropes with the help of neat sketches. What are the basic reasons of rope deteriorations and how to combat them ? 10

(*b*) Why is in the deep winding system the factor of safety of the winding rope chosen even below 6 ? Explain. What are the various tools to be used for rope testing ? 10

4. Explain, with illustrations, the construction, operation and maintenance of a turbine pump and a Mono pump. 10 + 10

Group B

5. (*a*) Compare among the hook plough, slicing plough and base plate Gleithobel plough with the help of illustrations. Under what conditions a plough is to be selected ? How are height control, depth control and horizon control of ploughs done ? 10

(*b*) What are the basic differences of a plough and a shearer ? Explain, with illustrations, the overpassing bi-directional cutting of coal by a Gleithobel plough. 10

6. (*a*) Explain, with illustrations, the ring main system and guaranteed set valve arrangements in the modern powered supports of longwall faces. What are the functions of an unloader valve ? Explain the power pack pump characteristics having a unloader valve and also when two power pack pumps are in parallel. 12

(*b*) What is mean load density ? Explain, with illustrations, various types of canopies of a shield support. 8

7. (*a*) Discuss various aspects of shearer drum design. Explain, with illustration, a chain-type haulage system. What are the demerits of chain-type haulage system ? 12

(*b*) Explain the full face system of cutting by a DERDS in the longwall face with the help of line diagrams. 8

8. (*a*) What are the basic factors which govern the design of a material handling plant on the surface ? Explain, with illustrations, a modern coal handling plant and a gravity reclaim stockpile. 12

(*b*) What factors play role during designing gravity reclaim stockpiles ? Explain a modern feeder for run-of-mine ore. 8

Group C

9. (A) Define/explain the following : 7 × 2

(*i*) Dozer door attached in a shearer.

(*ii*) Chain stripper in an armoured face conveyor.

(*iii*) Lemniscate linkage in a shield support.

(*iv*) Water hammer.

(*v*) Snub pulley in a belt conveyor.

(*vi*) Limit switch in the winding system.

(*vii*) Taper guide attached with the head gear structure.

(*B*) Select the *correct* answer for the following : 6 × 1

(*i*) A continuous miner is a
(*a*) cutting-cum-loading equipment.
(*b*) cutting equipment.
(*c*) loading equipment.
(*d*) transporting equipment.

(*ii*) The equipment which is *not* used in Bord and Pillar system of working is
(*a*) side discharge loader.
(*b*) load haul dumper.
(*c*) scraper.
(*d*) coal plough.

(*iii*) Under which of the following system Zener barriers are associated ?
(*a*) Increased safety
(*b*) Intrinsic safety
(*c*) Flame proof
(*d*) Statistical safety

(*iv*) Which one of the following powered roof supports does not contain a canopy ?
(*a*) Chock support
(*b*) Shield support
(*c*) Pure shield support
(*d*) Chock shield support

(*v*) A jackhammer drill machine does not contain one of the following units :
(*a*) Pawl and ratchet
(*b*) Gear box
(*c*) Rifle bar
(*d*) Piston

(*vi*) Which one of the following mining equipment *does not* incorporate a loading assembly ?
(*a*) Continuous miner
(*b*) Road header
(*c*) Dint header
(*d*) Gathering arm loader

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Given : 102 kg . m/s = 1 kW; 1 ton = 1000 kg

Group A

1. (*a*) Give a general account of the use of 'fluid power system' in mining equipment. Give examples. Name the various components that are involved to form a fluid power system and their functions. Which is the hydraulic law utilized to transmit fluid power to the operating points ? 3 + 2 + 4 + 2

   (*b*) Write *any three* on the following machine elements : (*i*) Coupling, (*ii*) clutch, (*iii*) spur gears, (*iv*) keys. 3 × 3

2. (*a*) Describe, with the aid of sketches, the layout scheme for a main sump pump showing the position of various accessories in the layout. Also, mention the purpose for which those accessories are installed in the pipeline. 6 + 6

(Turn Over)

(*b*) Compare ram pumps and centrifugal pumps, and give advantages and disadvantages of each type. Where are they particularly suitable in mining use? 4 + 4

Or

A pump is required to lift 360 m^3/hr against a total head of 204 m, taking all losses together. Calculate the power of the motor, if the pump has an efficiency of 75%. If the pump operates 10 hour a day and the motor efficiency is 90%, determine the daily electricity consumption and the energy cost. [Given: 1 litre of water weighs 1 kg and one kWh of energy costs Rs. 9] 4 + 4

3. (*a*) Why most of the high capacity deep shaft installations consider mainly multi-rope friction winders? Give reasons. Why is friction winder generally not suitable for shallow depth installation? 10

(*b*) How do you fix the capacity of a cage/skip for a given production? Assume your own conditions. 5

(*c*) The speed time diagram of a winding cycle for a shallow depth mine is almost a triangular shape. Explain. 5

4. (*a*) Name various types of rope haulage used underground and describe one type in detail with neat sketches. 10

(*b*) A rope haulage is driven by an electric motor which develops 50 kW brake power when running at 1450 rpm. The rope is wound on a drum 1.3 m effective diameter driven by the motor through gearing having a speed reduction of 50 to 1. If the overall efficiency is 80%, calculate the hauling speed and the pull in the rope. 10

Group B

5. (*a*) Which cutter loaders were most popular on mechanized coal faces in India in recent years. Give the specification of the cutter loader of your choice. Also, mention what is the other supporting equipment needed for the system. Draw a sketch and indicate the tentative location of cutter loader and supporting equipment. 3 + 4 + 4 + 4

(*b*) Write short notes on *any one* of the following: 5

(*i*) Pneumatic drill

(*ii*) An electric coal drill

6. (*a*) State what determines the (*i*) carrying capacity of a belt conveyor, (*ii*) power input required, and (*iii*) maximum length of the conveyor. 4 + 4 + 2

(*b*) Calculate the power required to drive a belt conveyor to carry a run of mine coal, at the rate of 180 tph and a distance of 250 m up a gradient 1 in 10. Assume that 50% of power is absorbed in overcoming frictional resistance to motion. 10

7. (*a*) Name the major components of a hydraulic shovel? What are the functions of those components? How a shovel operates? What is the working cycle of a shovel? 3 + 4 + 3 + 2

(*b*) What are the merits and demerits of a hydraulic shovel over rope shovel? 8

8. Write short notes on *any four* of the following: 4 × 5

(*a*) Gravity tension arrangement in an endless haulage

(*b*) End thrust of a turbine pump

(*c*) Provision of superelevation on a loco track in curves

(*d*) Rapid loading system

(*e*) Power developed by a 5 ton loco, weighing 5 ton on level when moving at a speed of 10.8 km/h and hauling a train of 45 ton. The tractive resistance of loco and train is 10 kg/ton. Loco efficiency is 80%.

Group C

9. Answer the following (choose the *correct* statement) : 10 × 2

(*i*) To make a hole through a tough abrasive rock, you will select

(*a*) high rpm rotary electric drill.

(*b*) rotary hydraulic drill.

(*c*) pneumatic rotary percussive drill.

(*ii*) The static factor of safety of a winding rope is the ratio of

(*a*) rope breaking load to the weight of maximum rope length.

(*b*) rope breaking load to the weight of maximum rope length and the dynamic load on the rope.

(*c*) rope breaking load to the weight of maximum rope length and the empty weight of the container.

(*d*) rope breaking load to the weight of maximum rope length and the weight of the loaded container.

(*iii*) When power is transmitted between two shafts at a distance, the effective equation is $T_1/T_2 = e^{\mu\varphi}$. Write the machines where this equation is applicable.

(*a*) Drive for direct haulage

(*b*) Drive for endless haulage

(*c*) Drive for A.F.C. conveyor

(*d*) Drive of friction winder

(*iv*) Which one is a loading mechanism in a long wall mechanized shearer face ?

(*a*) Moving chains of AFC

(*b*) Pushers of the powered support

(*c*) Rotation of cutting drum

(*d*) Roll rack arrangement for shearer

(*v*) Considerable dead weight (ballast) is kept on the platform of the chasis at the opposite end of a dragline boom. These form a part of the design and are used to

(*a*) increase ground pressure.

(*b*) fill the void space on the deck.

(*c*) increase the stability of the machine during operation.

(*d*) None of the three above.

(*vi*) To increase the discharge head of a centrifugal pump,

(*a*) reduce the diameter of a delivery pipe.

(*b*) increase the motor power.

(*c*) reduce the diameter of the suction pipe.

(*d*) increase the motor rpm and power.

(*vii*) The reasons for cavitations in a turbine pump are

(*a*) when the total suction head reaches about 10 m.

(*b*) when water temperature is high.

(*c*) when delivery pipe length is long.

(*d*) when there is leakage in the delivery pipe.

(*viii*) The draw bar pull required by a loco to haul 20 mine cars each of a gross weight of 4 ton having tractive resistance 10 kg/ton, on an incline with a gradient of 1 in 100 in favour of load is

(*a*) 800 kg

(*b*) 0 kg

(*c*) 40 kg

(*d*) 1600 kg

(*ix*) Choose the proper metal/alloy for the following items (forge steel, bronze, cast iron, wrought iron, silicon-Mn steel, aluminium)

(*a*) A bed plate

(*b*) Cage chains

(*c*) Bushes of a bearing

(*d*) Axle

(*x*) The endless rope haulage is adopted in Indian mines because of its

(*a*) applicability to a wide range of mining conditions.

(*b*) flexibility and economy.

(*c*) applicability in steeply inclined seams.

(*d*) high speed performance.

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Group A

1. (*a*) What are the factors to be considered by the manger to decide the number of loaded tubs to be attached in a set of train moving up the gradient ? Name the safety devices to be placed along the track for a direct rope haulage. Give relevant sketches. 4 + 8

(*b*) An endless haulage operates on a roadway 850 m long dipping at 1 in 16 and draws 400 ton of coal in a shift of effective 5 hr time. The load weighs 1400 kgf each and empties 500 kgf. Rope dia=28 mm, tub friction =1/40, rope friction =1/20, rope speed = 3 kmph. Estimate the requirement of power when loads are pulled up the gradient. 8

(*Turn Over*)

2. (*a*) What are the advantages of underrope type endless haulage over the over-rope type endless haulage ? State the specific use of tail rope haulage in mines. Give a tabular difference between direct rope haulage and endless rope haulage. 4 + 4

(*b*) 135 ton of coal is to be hauled by a direct rope haulage in a shift of 6 hr hauling time where the length of haulage road is 1100 m with a gradient of 1 in 8. The rope speed is 6 kmph ; set changing time 1 min. Capacity of tub is 1.5 ton each. Calculate the number of tubs/train ? 6 + 6

3. (*a*) State the limiting factors which affect the use of conveyor in mines. How do you take care of belt in a conveyor ? What do you mean by average loading factor (ALF) ? On which factors the ALF depend ? 4 + 4

(*b*) Describe, with the help of a suitable single line sketch, a five level heading underground district where coal is won with the combination of dip-rise scraper chain conveyor (2 nos.) and 2 each belt conveyors at trunk and gate end side. Show separately sequence control operation of conveyors. 2 + 2 + 8

4. (*a*) What are the conditions suitable for diesel loco in mines ? How will you tackle the toxic gases produced by diesel loco in underground mines ? 4 + 3

(*b*) Show the principle of working exhaust conditioner through a sketch and also, with the help of a flow diagram, where other units of diesel loco are also incorporated. What are the conditions suitable to use trolley wire loco in mines ? 6 + 7

Group B

5. (*a*) Sketch and describe at least two different types of high angle conveyor (HAC) for the purpose of bulk material transportation. 6 + 6

(*b*) A conveyor is 600 m long and carrying coal of bulk density 0.8 ton/m^3 up a gradient of 1 in 60 at the rate of 220 ton/hr. If belt width is 0.75 m and cross-sectional area of the material is one-tenth of square of the belt width, then determine belt speed ? 8

(*a*) Show the time elemental break up of SDL during its use as face loading machine in underground mines. Give justification as applicable. 8

(*b*) Sketch and describe the combination of fleets of SDL machines working in a three level headings and a five level headings district. 6 + 6

7. (*a*) Give a suitable layout of energy train used in longwall powered support system. 8

(*b*) Detail a salvaging strategy of longwall unit deployed to produce five lac tons of coal per annum. Assume your own conditions. 12

8. Write short notes on *any four* of the following : 4 × 5

(*a*) Jack Hammer drill

(*b*) Cable belt conveyor

(*c*) Pneumatic conveying principles

(*d*) Cutting unit of surface continuous miner

(*e*) Pulp transportation in hydraulic mining

(*f*) Grader in opencast mine

Group C

9. Select the *correct* or nearest *correct* answer for the following : 10 × 2

(*i*) Friction wheels with differential gear is used with

(*a*) belt conveyor.

(*b*) cable belt conveyor.

(*c*) shaker conveyor.

(*d*) high angle conveyor.

(*ii*) If the track gauge of underground haulage is 0.6 m radius of curve 2 m, velocity of train 2 m/s, then the amount of superelevation is.

(*a*) 0.02

(*b*) 0.12

(*c*) 0.22

(*d*) 0.32

(*iii*) Slip ring motor with controller is used with

(*a*) direct rope haulage.

(*b*) belt conveyor.

(*c*) jigging plant.

(*d*) tail rope haulage.

(*iv*) Jigging or reciprocating movement is associated with

(*a*) shaker conveyor.

(*b*) belt conveyor.

(*c*) diesel loco.

(*d*) cable belt conveyor.

(*v*) Rotation of impeller inside the pump forces water to enter in the suction pipe. This is effected due to

(*a*) reduction.

(*b*) suction

(*c*) revolution.

(*d*) torque.

(*vi*) Turbine or centrifugal pump works at its best efficiency while dealing with

(*a*) simple volute casing.

(*b*) reduced head.

(*c*) exact head.

(*d*) diffusion channel.

(*vii*) Capacity to continue pumping operation even if air enters into the water pipelines is known as

(*a*) core.

(*b*) shore.

(*c*) driver.

(*d*) carrier.

(*viii*) Which one of the following haulages is preferred for undulating roadways ?

(*a*) Direct rope haulage

(*b*) Endless haulage

(*c*) Tail rope haulage

(*d*) Main and tail rope haulage.

(*ix*) As per mining regulation, for every shaft exceeding 100 m depth and during hoisting men, the speed should not exceed

(*a*) 0.5 m/s

(*b*) 1 m/s

(*c*) 1.5 m/s

(*d*) 5 m/s

(*x*) Removal of metal from outer wires in a rope is a type of

(*a*) plastic wear.

(*b*) abrasive wear.

(*c*) differential wear.

(*d*) temporary wear.

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Group A

1. (*a*) Explain turbine pump used in underground mine with its constructional details. Also, explain its characteristic curves. 8 + 6

(*b*) Calculate the power of electric motor for a pump which can be used for dewatering at the rate of 900 litre/min in an underground mine having depth 612 m. Consider efficiency of pump be 90%. 6

2. (*a*) Explain the principle of friction winding system. Compare friction winding system with the drum winding system. 4 + 4

(*b*) Write short notes on following : 4 × 3

(*i*) Drum winding

(*Turn Over*)

(*ii*) Fleet angle

(*iii*) Safety hook

(*iv*) Ward Leonard system

3. (*a*) Discuss constructional features, applications and limitations of a belt conveyor system for haulage of iron ore from mines to crushing plant. 10

(*b*) An endless haulage operates on a roadway 800 m long dipping at 1 in 15 and draws 600 ton of coal in a shift (1 shift = 7.5 hr effective time). The loads weigh 1500 kgf each and the empties 500 kgf. The rope weighs 3 kgf/m, tub friction is 1/50 and rope friction = 1/10. Speed of the rope is 4 km/hr. Estimate the power required at the surge wheel. The loads are pulled up the gradient. 10

4. (*a*) Explain the principle of hydraulic power transmission. Compare hydraulic *vs.* pneumatic power transmission system. 10

(*b*) What is clutch ? Name different types of clutches used on the common machines in the mines and describe a jaw clutch with a neat sketch. 10

Group B

5. (*a*) Discuss constructional features, applicability and limitations of a bicable aerial ropeway. 10

(*b*) Explain loading arrangements of aerial ropeway with neat sketches. 10

6. (*a*) Discuss the mechanics and applicability conditions of percussive, rotary and rotary-percussive drilling machine. 10

(*b*) Describe various salient features of a road header machine. Enumerate the advantages and limitations of a road header. 10

7. (*a*) Discuss the constructional features, working and applicability of drill jumbo machine used in mines. 10

(*b*) Discuss the recent developments took place in bulk material handling technology. 10

8. Write short notes on *any four* of the following : 4 × 5

(*i*) Bucket wheel excavator

(*ii*) Hydraulic conveying

(*iii*) DERD

(*iv*) Angle station in aerial ropeway

(*v*) Reclamation of bulk material

Group C

9. (A) Choose the *correct* answer for the following : 8 × 1

(*i*) Water will not be delivered by a centrifugal pump due to

(*a*) lack of priming.

(*b*) wrong direction of rotation.

(*c*) too low discharge head.

(*d*) partial obstruction at discharge outlet.

(*ii*) According to mine regulations, the value of fleet angle, α, (in degree) of a drum winder installation lies in the range of

(*a*) $1.5 < \alpha \leq 2.0$

(*b*) $0 < \alpha \leq 1.5$

(*c*) $2.0 < \alpha \leq 2.5$

(*d*) $2.5 < \alpha \leq 3.0$

(*iii*) Which one of the transport machine is mainly used in development heading ?

(*a*) Slusher

(*b*) Cavo loader

(*c*) LPDT

(*d*) Dumper

(*iv*) A drum shearer is mounted on

(*a*) its own skid.

(*b*) separate rail.

(*c*) AFC.

(*d*) support frame.

(*v*) Recapping a winding rope is done to

(*a*) increase the flexural strength of the rope.

(*b*) increase the flexibility of the rope.

(*c*) remove a portion of the rope subjected to deterioration.

(*d*) prevent the rope from excessive rusting.

(*vi*) Clifton pulley is used in

(*a*) direct rope haulage.

(*b*) endless haulage.

(*c*) main and tail haulage.

(*d*) gravity haulage.

(*vii*) The suitable action/process for bucket wheel excavator is

(*a*) terracing.

(*b*) reaming.

(*c*) keycut.

(*d*) pulsating impact.

(*viii*) Mode of unloading for Granby mine car is

(*a*) bottom opening.

(*b*) both side tilting.

(*c*) single side opening.

(*d*) both side opening.

(B) Explain the following in brief : 6 × 2

(*i*) Tractive effort

(*ii*) Match factor

(*iii*) Mono pump

(*iv*) Rope guides

(*v*) Blast hole drill

(*vi*) Ripper