

WINTER – 2019 EXAMINATION

Subject Name: Intensive Care Equipment

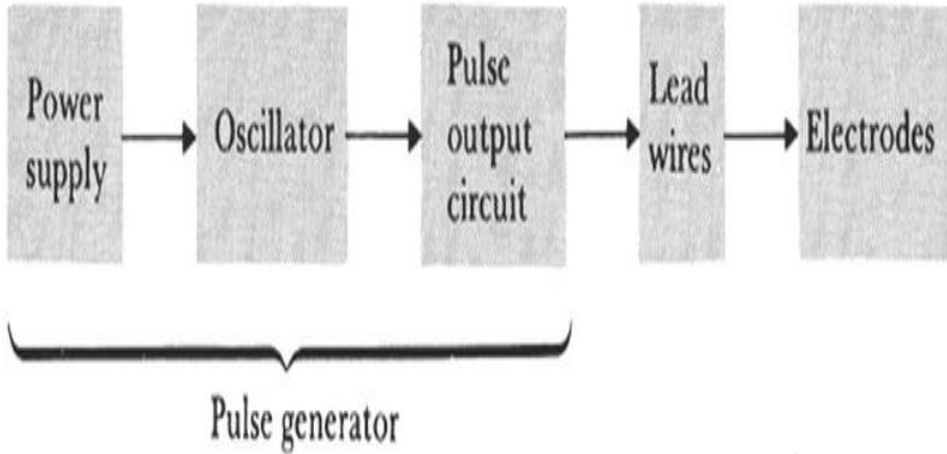
Model Answer

Subject Code:

22548

Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance. Not applicable for subject English and Communication Skills.
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		Attempt any FIVE of the following:	10 M
	a)	<p>Draw block diagram of basic cardiac pacemaker. Ans:</p>  <p style="text-align: center;">Fig: Block diagram of basic cardiac pacemaker</p>	02 M
	b)	<p>Give concept of fibrillation of heart and state need of defibrillator. Ans: Concept of fibrillation of heart: Fibrillation is the rapid, irregular and unsynchronized contraction of muscle fibers. During fibrillation the normal rhythmic contraction of either the atria or ventricles are replaced by rapid irregular twitching of the muscle wall. Need of defibrillator: A defibrillator is an electronic device that creates sustained myocardial depolarization of patient's heart in order to stop ventricular fibrillation or atrial fibrillation.</p>	<p>01 M</p> <p>01 M</p>

c) **Draw labelled diagram of suction apparatus.**
Ans:

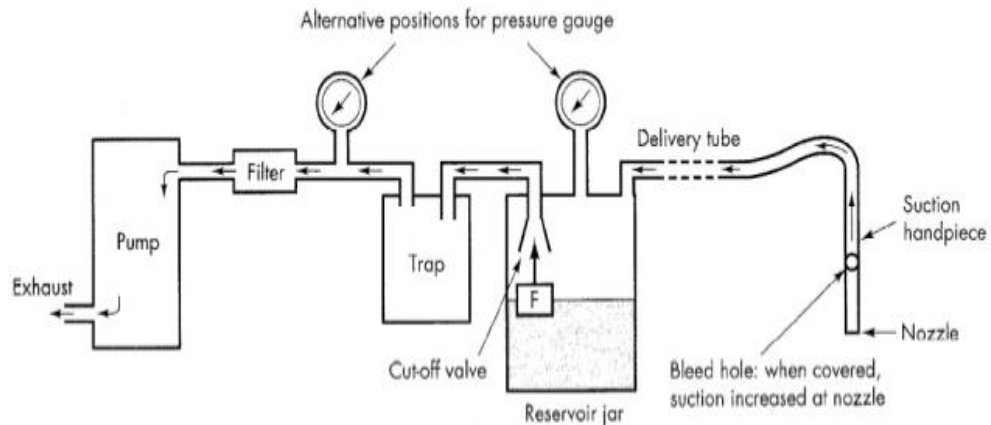


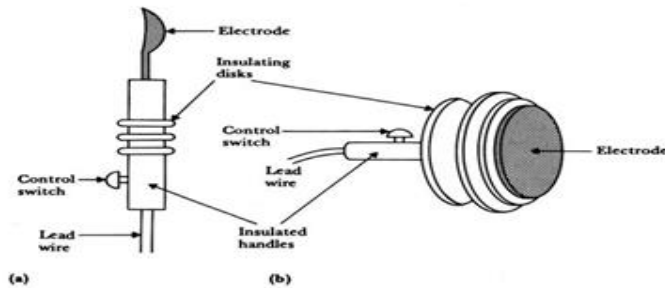
Fig: Suction apparatus

(any relevant diagram should be considered)

02 M

d) **Draw neat sketches of defibrillator electrodes. (any two)**
Ans:

Defibrillator: Electrodes



Electrodes used in cardiac defibrillation (a) A spoon-shaped internal electrode that is applied directly to the heart. (b) A paddle-type electrode that is applied against the anterior chest wall.

Fig: Defibrillator electrodes

(Consider any relevant diagram)

02 M

e) **List different life support equipments. (any two)**
Ans:

Life support equipment:

1. Hemodialysis machine
2. Baby incubator
3. Anesthesia machine
4. Heart lung bypass machine.

02 M

f) **State need of baby incubator.**
Ans:

Need of baby incubator:

1. To provide controlled environment for new born or premature babies, who needs special care.
2. To monitor different aspects of children's environment in order to create ideal conditions for survival.
3. To regulate oxygen temperature and humidity level to protect infant from pollutants and infections.

02 M



	<p>g) State the application of</p> <ul style="list-style-type: none">i. NICUii. ICU <p>Ans: Application of :</p> <ul style="list-style-type: none">1. NICU: Newborn babies who need intensive medical attention are often admitted into a special area of hospital called Neonatal Intensive Care Unit.2. ICU: Intensive care unit provides to patients with severe or life threatening illness and injuries which require constant care close supervision from life support equipment and medication in order to ensure normal bodily functions.	<p>01 M</p> <p>01 M</p>
2.	<p>Attempt any <u>THREE</u> of the following:</p>	<p>12 M</p>
	<p>a) Give different pacing modes of pacemaker and state the condition of application for each mode.</p> <p>Ans: Pacing modes of pacemaker and condition of application for each mode:</p> <ul style="list-style-type: none">1. Asynchronous pacemaker (Competitive pacemaker): Asynchronous pacemaker that produces pulses at fixed rate and independent of cardiac function. This pacemaker is suitable for patients with either a stable, total AV block, a slow rate atrial arrhythmia.2. Synchronous pacemaker (Non-Competitive pacemaker): Synchronous mode sensing circuit for an intrinsic depolarization potential. If this is absent, a pacing response is generated. The non- Competitive pacemaker, which uses pulse generator that are either ventricular programmed or atrial programmed.<ul style="list-style-type: none">i. Ventricular programmed synchronous pacemaker: Ventricular programmed pacemaker are designed to operate either R-wave inhibited (demand type) or R-wave triggered (standby type).<ul style="list-style-type: none">a) Ventricular programmed R-wave inhibited (demand type): This pacemaker senses the presence or absence of R-wave. Suppose no R-wave is generated, then this pacemaker will generate its waveform to activate the heart.b) Ventricular programmed R-wave triggered (standby type): R-wave triggered (standby type) uses the R-wave to produce impulses. In this case, the impulses produced are to strengthen the natural pulse.ii. Atrial programmed synchronous pacemaker: In the case of complete heart block where the atria are able to depolarize but the impulse fails to depolarize the ventricles, atrial synchronous pacing may be used.	<p>04 M</p>
	<p>b) List technical specification of DC defibrillator. (any four)</p> <p>Ans: Technical specifications of DC defibrillator:</p> <ul style="list-style-type: none">1. Power input to be 230VAC, 50-60 Hz or Battery: 9VDC, 4.2 Ah2. Energy o/p: For adults 150J * 50 Ω load & For children 50J * 50 Ω load3. Shock to Shock cycle time: typically < 20 sec4. Capacity: min 200 Shocks or 4 hours of operating time5. Capability to deliver shocks from 2 Joules to 200 Joules6. Capable of self test7. Wave Form: Biphasic, current based	<p>04 M</p>
	<p>c) Draw a labelled spirogram. Also show ideal values of all volumes on spirogram.</p> <p>Ans:</p>	

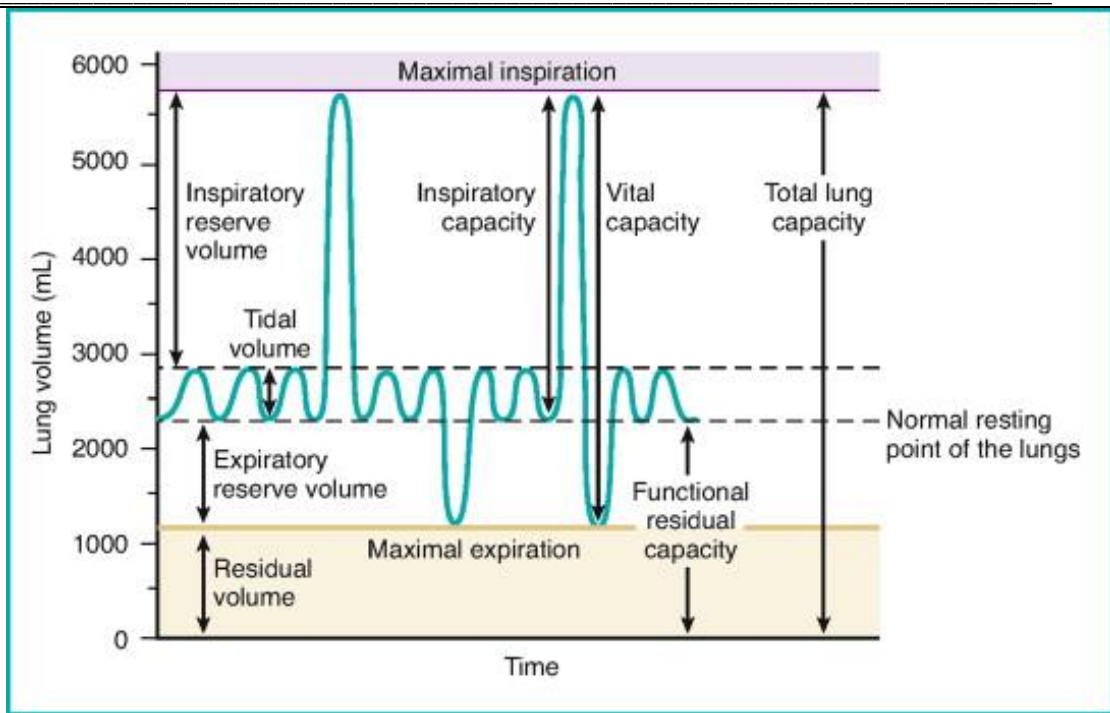


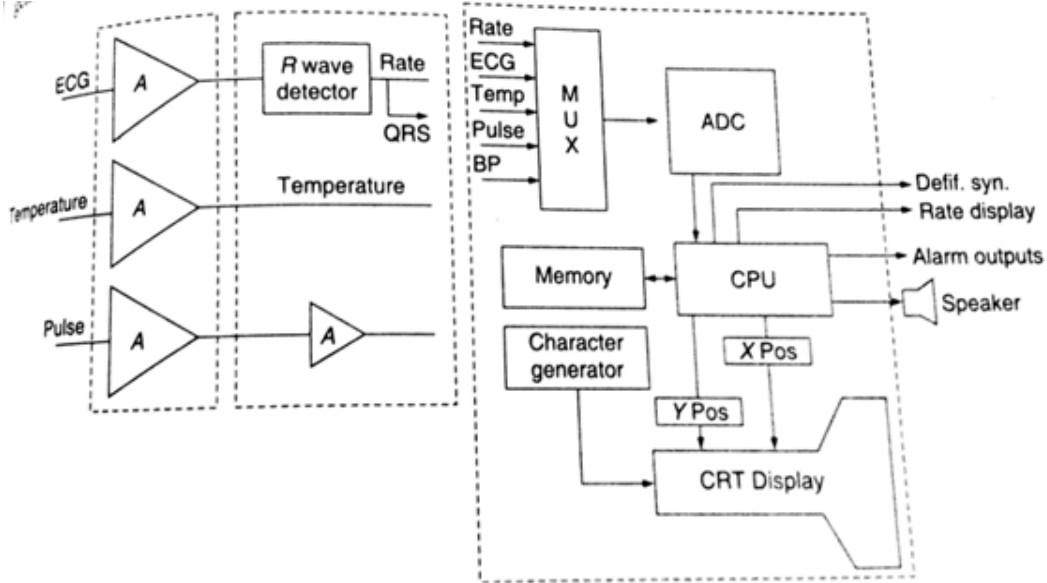
Fig: Spirogram

04 M

d) Identify the instrument which is used to monitor various parameters of a patient. Draw block diagram of it.

Ans:

Bedside monitor (Multiparameter monitor) is used to monitor various parameters of a patient.



Block diagram of a typical bed side monitoring system.

Fig: Block diagram of Bedside monitor

01 M

03 M

3. Attempt any **THREE** of the following:

12 M

a) For kidney failure of any patient, which life supporting equipment is used. Draw its block diagram.

Ans: Hemodialysis machine is used as life support equipment for kidney failure of any patient.

01 M

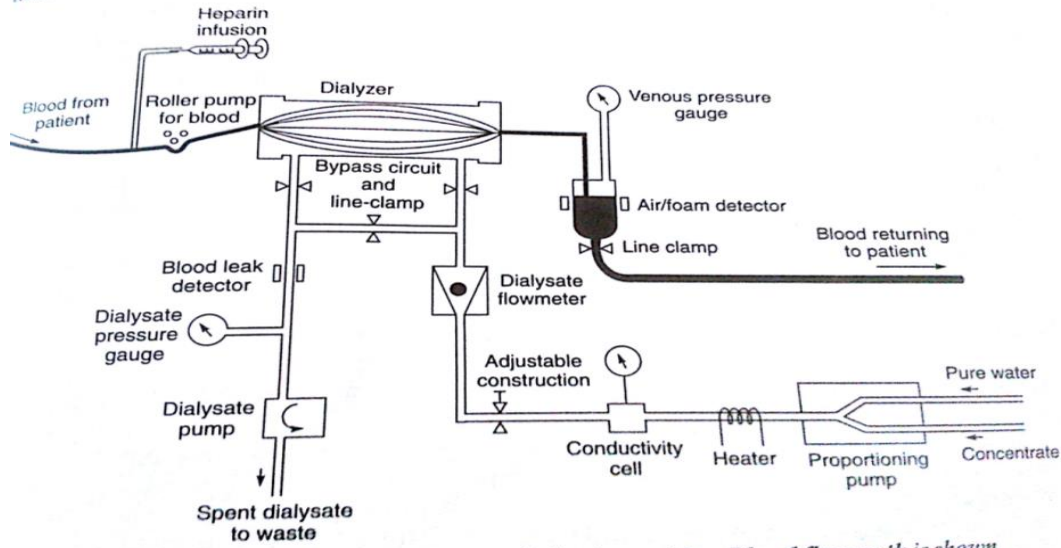


Fig: Hemodialysis machine

03 M

b) **Draw & give function of programmable microprocessor based infusion pump.**
Ans:

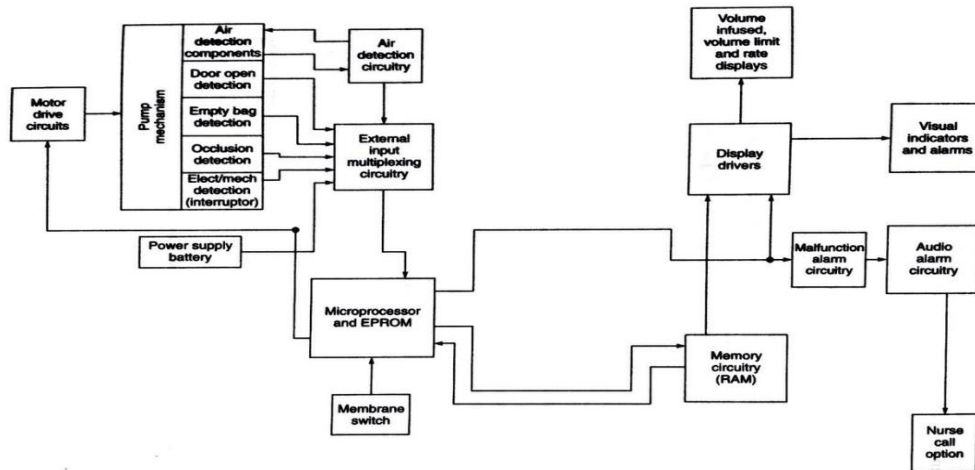


Fig: Programmable microprocessor based infusion pump

The above figure shows block diagram of infusion pump which operates under the control of microprocessor. The microprocessor controls all operators programmable and alarm condition sensors. A synchronous stepping motor is used to operate the pumping mechanism accordingly. The pumps offer user programmable control over both the dose volume and the rate at which the dose is delivered. The pump provides patient safety by monitoring several alarm situations. In such situation the pump stop fluid delivery, sounds an audible alarm and displays a visual alarm indicator. The unit has the following three types display:

- Volume infused which indicates the cumulative volume (in ml) which the pump has delivered.
- Volume limits indicating the volume limit (dose), in ml, which the operator has selected.
- Rate indicating the rate (ml/hour) which the operator has selected.

The nurse call circuit monitors the inputs to the audio alarm circuit. If any of the alarm situations arise, the nurse call relay is energized. The motor is operated according to the control programme in the microprocessor memory. A four-phase stepping motor is used, with a step angle of 7.5 degrees and gearbox reduction ratio of 20:1. Due to this

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	reduction, 1920 pulses yield one full revolution of the cam of the pumping mechanism. Each cam shaft revolution and the resulting cycle of the pumping mechanism delivers approximately 2 ml of the fluid. The delivery of fluid to the patient is non-pulsatile and nearly continuous since each ml delivered in approximately 960 increments.													
c)	<p>For emergency cardiac situations occur on airports, railway station etc., which defibrillator is used. Give it's concept in brief.</p> <p>Ans:</p> <p>For emergency cardiac situation occur on airports, railway station etc Automated external defibrillator (AED) is used.</p> <p>An important development in the field of defibrillator has been the development and successful use of smart automatic or advisory external defibrillator (AED) which is capable of accurately analyzing the ECG and of making reliable shock decision. They are designed to detect ventricular fibrillation with sensitivity and specificity comparable to that of well trained paramedics then deliver or recommended (advisory) an appropriate high energy defibrillating shock. AED require self adhesive electrode instead of hand held paddles for two reasons. Firstly, the ECG signal acquired from self adhesive electrodes usually contains less noise and has higher quality. Hence, it allows a faster and more accurate analysis of ECG and therefore facilitates better shock decision. Secondly, "Handoff: defibrillation is safe procedure for the operator especially if the operator has little or no training. An automatic external defibrillator is the ability of the device to accurately assess the patient's heart and appropriate therapy decision. It is small, light and virtually maintenance free. While it is on standby mode for long periods, the device automatically self tests its electronic circuitry every day and periodically performs an internal discharge and recalibration. The device is powered by long life disposable lithium battery with enough capacity for 75 discharges and one year of self test. It uses a low energy biphasic waveform.</p>	<p>01 M</p> <p>03 M</p>												
d)	<p>Compare fixed and demand modes of external pacemaker. (any four point)</p> <p>Ans:</p> <table border="1"> <thead> <tr> <th>Fixed Mode</th> <th>Demand Mode</th> </tr> </thead> <tbody> <tr> <td>1) Pacing is competitive</td> <td>1) Pacing is non competitive</td> </tr> <tr> <td>2) It functions regardless of patients natural heart rhythm</td> <td>2) It considers patients heart rhythm.</td> </tr> <tr> <td>3) It is asynchronous mode</td> <td>3) It is synchronous mode</td> </tr> <tr> <td>4) Number of pulses per minute are fixed</td> <td>4) Number of pulses per minute are not fixed</td> </tr> </tbody> </table> <p>Table: Comparison of fixed and demand modes of external pacemaker</p>	Fixed Mode	Demand Mode	1) Pacing is competitive	1) Pacing is non competitive	2) It functions regardless of patients natural heart rhythm	2) It considers patients heart rhythm.	3) It is asynchronous mode	3) It is synchronous mode	4) Number of pulses per minute are fixed	4) Number of pulses per minute are not fixed	04 M		
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4.	Attempt any <u>THREE</u> of the following:	12 M												
a)	<p>Compare AC and DC defibrillator. (any four point)</p> <p>Ans:</p> <table border="1"> <thead> <tr> <th>AC defibrillator</th> <th>DC defibrillator</th> </tr> </thead> <tbody> <tr> <td>1. It is not commonly used.</td> <td>1. It is commonly used.</td> </tr> <tr> <td>2. It produce undesirable side effect.</td> <td>2. It does not produce undesirable side effect.</td> </tr> <tr> <td>3. Capacitor is not used.</td> <td>3. Capacitor is used.</td> </tr> <tr> <td>4. At transformer secondary side diode is not used.</td> <td>4. At transformer secondary side diode is used.</td> </tr> <tr> <td>5.</td> <td>5.</td> </tr> </tbody> </table>	AC defibrillator	DC defibrillator	1. It is not commonly used.	1. It is commonly used.	2. It produce undesirable side effect.	2. It does not produce undesirable side effect.	3. Capacitor is not used.	3. Capacitor is used.	4. At transformer secondary side diode is not used.	4. At transformer secondary side diode is used.	5.	5.	04 M
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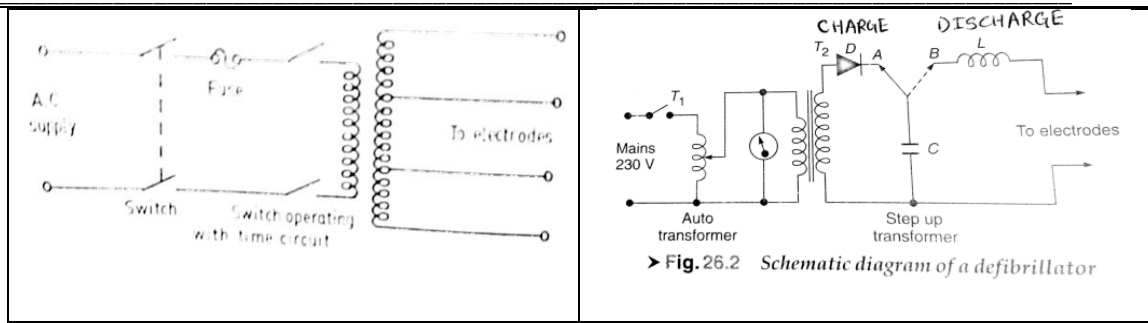


Table: Comparison of AC and DC defibrillator

b) Give significance of pacemaker leads.

Ans:

Significance of pacemaker leads:

1. Unipolar: In unipolar system one electrode is inside or on the heart & is the stimulating electrode, & the second electrode is usually a large metal plate attached to the pulse generator. The current in this case flows between the pacing electrode in the heart & the indifferent electrode via the body tissue.
2. Bipolar leads: Bipolar leads which have two electrodes positioned in the heart are designed with a coaxial connector requiring only a single receptacle resulting in improvement in the size of bipolar pacemaker connector. In the bipolar electrode system both electrodes are approximately of the same size and both are placed inside or on the heart so that current flows between the two electrodes.
3. Myocardial leads: This is connected to outer wall of heart muscle.
4. Endocardial leads: This is connected to inner side of heart chamber.

04 M

c) Draw and label the block diagram of heart lung bypass machine.

Ans:

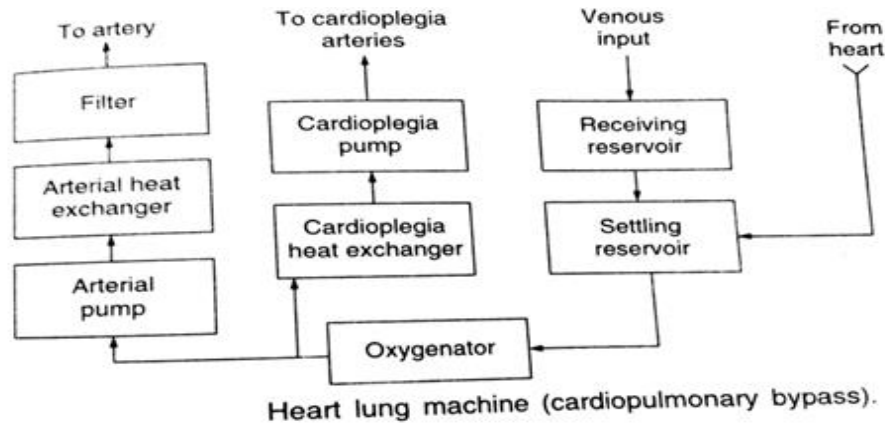


Fig: Block diagram of heart lung bypass machine

04 M

d) State the need of balloon pump in OT.

Ans:

Need of balloon pump in OT:

The intra aortic balloon pump (IABP) is now the most commonly used mechanical assist device in cardiac operative procedures. An IABP also might be used to help to patient recover from surgery to reopen or bypass a blocked artery near patient's heart. Intra-aortic balloon pump (IABP) is the most usable tool of temporary mechanical circulatory support for cardiac surgical patients suffered from low cardiac output in the early postoperative phase. It is used in patients who have severe heart failure, including those with a severe heart attack and those are recovering from open heart surgery or waiting for heart transplant.

04 M

- e) **The defibrillator machine has following problems displayed on its monitor screen. Identify the cause and give solutions for it.**
(i) Energy not delivered properly.
(ii) Machine doesn't get on.

Ans:

Fault	Causes	Solution
Energy not delivered properly.	<ol style="list-style-type: none"> 1. Electrode cable not connected properly. 2. Energy selector switch faulty. 3. Not proper contact of electrode and patient chest. 	<ol style="list-style-type: none"> 1. Check the Electrode cable Check replace and the electrodes. 2. Check the discharging circuit. 3. Check energy selector switch.
Machine doesn't get on.	<ol style="list-style-type: none"> 1. No supply. 2. Fuse blown. 3. Faulty power cable. 	<ol style="list-style-type: none"> 1. Check and provide proper Supply. 2. Check and replace the fuse. 3. Check and replace the power cable.

Table: Defibrillator machine faults cause and solution

04 M

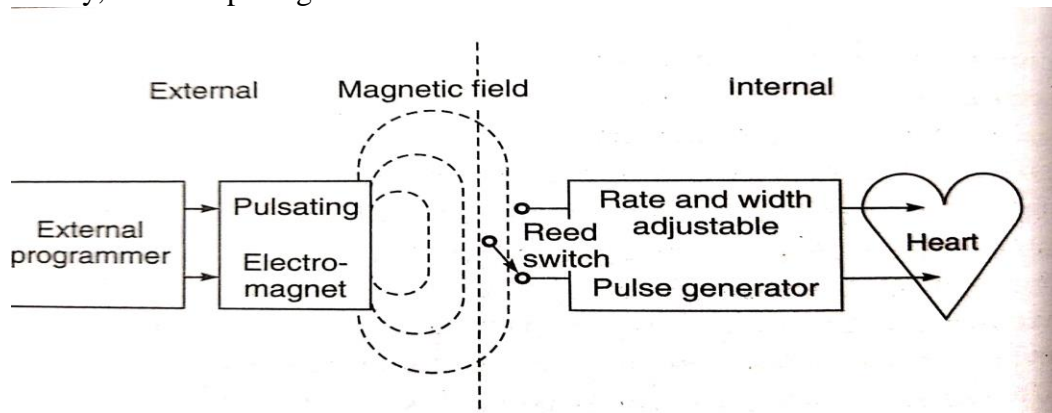
5. **Attempt any TWO of the following:**

12 M

- a) **Give significance of programmable pacemaker. Draw and explain labelled diagram for same.**

Ans:

Programmable Pacemakers that the specific functions they perform can be altered at any time. Programming a pacemaker is done by wirelessly transmitting new instructions to the generator, using a special device called a programmer. Programmable pacemaker in which the pacing mode and/or parameters can be changed noninvasively with an external programmer adjustable parameters rate, pulse amplitude and width, sensitivity, mode of pacing.



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A programmable pacemaker consists of two parts: the external unit which generates programmed stimuli which is transferred to an internal unit by one the several communication techniques. Fig shows a functional block diagram of the programming interface, The commonly used methods of transmitting information are: (i) magnetic- an electromagnet placed on the surface of the body establishes a magnetic field which

02 M



	<p>penetrates the skin and operate the pacemaker's reed switch (ii) radio frequency waves – the information can be transmitted over high frequency electromagnetic waves which are received inside the body by antenna. The antenna is usually in the shape of coil housed within the pacemaker, (iii) acoustic-ultrasonic pressure waves from a suitable transducer placed over the skin, can operate the human body. They are received by a suitable receiver in the pacemaker which carries out the desired function. (Consider ventricular programmed or atrial programmed pacemaker)</p>	
	<p>b) Give working of nebulizer, with neat diagram. List applications (any 3) of it. Ans: Working of nebulizer: Nebulizer is an instrument which is used in drug delivery. When therapy requires that water or some types of medications be suspended in the air as an aerosol, a device called nebulizer is used. In this device water or medication is picked up by a high velocity jet of oxygen or some other gas and thrown against one or more baffles or other surface. To break the substance into controllable sized droplets or particles which are then applied to the patients via respirator.</p> <p style="text-align: center;">R. F. Current Ultrasonic Energy</p> <div style="text-align: center;"><pre>graph LR; G[Generator] --> UT[Ultrasonic Transducer]; UT --> C[Chamber]; C --> P[To patient]; R[R. F. Current] --> UT; U[Ultrasonic Energy] --> UT; M[Medicine] --> C;</pre></div> <p>Applications: Nebulizers are commonly used for treatment of</p> <ol style="list-style-type: none">1. Cystic fibrosis2. Asthma3. Lung infections, such as pneumonia4. Other respiratory diseases5. It can be used to deliver bronchodilator (airway-opening) medications	<p>02 M</p> <p>02 M</p> <p>02 M</p>
	<p>c) Give steps for maintenance of baby incubator. Ans: Maintenance steps of baby incubator:</p> <ol style="list-style-type: none">1. Check that all nuts and bolts are tightened fully.2. Examine the exterior of the unit for cleanliness and general physical condition.3. Examine the AC power plug for damage.4. Inspect the cord for signs of damage.5. If the device has a switch-type circuit breaker, check that it moves freely.6. Check the condition of all tubing, cuff, hoses, and bulbs (if present).7. Switch on the instrument8. Calibrate the temperature sensor9. Calibrate the humidity sensor10. Adjust the alarms range for all parameters11. Take a performance test.	<p>06 M</p>
6.	<p>Attempt any TWO of the following:</p>	<p>12 M</p>
	<p>a) Name the instrument which is used to give artificial respiration to patient in ICU. State and explain different modes used in the same device. (any five modes) Ans: Ventilator is used to give artificial respiration to patient in ICU. Modes of Ventilator:</p> <ol style="list-style-type: none">1. Assist mode: A ventilator which augments the inspiration of the patient's	<p>01 M</p>



		<p>inspiratory effort. A pressure sensor detects the slight negative pressure that occurs each time the patient attempts to inhale and triggers the process of inflating the lungs. Thus the ventilator helps the patient to inspire when needed. A sensitivity adjustment provided on the equipment helps to select the amount of effort required on the patient's part to trigger the inspiration process. The assist mode is required for those patients who are able to breathe but is unable to inhale a sufficient amount of air or for whom breathing requires a great deal of effort.</p> <ol style="list-style-type: none">2. Controller: A ventilator which operates independent of the patient's inspiratory effort. The inspiration is initiated by a mechanism which is controlled with respect to time, pressure or another similar factor. Controlled ventilation is required for patients who are unable to breathe on their own.3. Assist/control mode: A ventilator which combines both the controller and assistor functions. In these devices, if the patient fails to breathe within a pre-determined time, a timer automatically triggers inspiration process to inflate the lungs. Therefore, the breathing is controlled by the patient as long as it is possible, but in case the patient should fail to do so, the machine is able to take over the function. Such devices are most frequently used in critical care units.4. Spontaneous Ventilation: This is a ventilation mode in which the patient initiates and breathes from the ventilator at will.5. Mandatory Ventilation: A ventilator operating in mandatory mode must control all aspects of breathing such as tidal volume, respiration rate, and inspiratory flow pattern and oxygen concentration of the breath.6. Continuous Positive Airway Pressure (CPAP): CPAP is a spontaneous ventilation mode in which the ventilator maintains a constant positive pressure, near or below PEEP Level, in the patient's airway while the patient breathes at will.7. Positive End Expiratory Pressure (PEEP): PEEP is a therapist-selected pressure level for the patient airway at the end of expiration in either mandatory or spontaneous breathing. PEEP is used to increase the end-expiratory lung volume (EELV) or prolong expiration with a potentially similar effect on the EELV.	<p>05 M</p>
	<p>b)</p>	<p>State different needs of bedside and central monitor. List technical specifications of bedside monitor. (any four) Ans: Need of bedside monitor: Bed side monitoring system used for measuring the values of patient's important physiological parameters continuously or automatically. The objective of this system is having quantitative assessment of the important physiological variables of the patients during critical periods of their biological function.</p> <ol style="list-style-type: none">1. When critically ill patients recovering from surgery or serious illness are often placed in intensive care units at that time there physiological parameters are monitored by bed side monitoring system.2. During lengthy operative procedures to maintain intimate contact with the patients vital signs.3. When patient is connected to life support apparatus.4. During surgical operation the patient is deprived of several natural reaction mechanisms which normally restore abnormalities in his physical condition in this case indications or alarms that cannot be given by the patient himself can be presented by bed side monitoring equipment. <p>Need of Central monitor: Central monitoring is the process of acquiring & recording the physiological parameter of different patients simultaneously on a single monitor at central station. In</p>	<p>02 M</p>



	<p>ICU the no. of critical patient is always high monitoring the physiological parameter for each patient is done by using bedside monitor but in some cases to reduce the manpower require delivering care</p> <p>Technical specifications of bedside monitor</p> <ol style="list-style-type: none"> 1. Power supply: 230v AC 50 Hz or Battery 2. Temperature measurement range: 5~50°C 3. Respiration measurement Method: Thoracic impedance between (RA-LL) 4. Respiration measurement range: Adult: 7~120rpm; Neonate/ Pediatric: 7~150rpm 5. SPO2 measurement range: 0-100% 6. Pulse Rate range: 20-300bpm 7. ECG: Lead mode: 5-lead (R, L, F, N, C) 8. Heart rate range: Adult: 15~300bpm; Neonate:/ pediatric: 15~350 bpm 	<p>02 M</p> <p>02 M</p>
<p>c)</p>	<p>Choose the following instrument related to NICU and explain it with neat sketch:</p> <ol style="list-style-type: none"> Heart - lung bypass machine Hemodialysis machine Baby incubator Anaesthesia machine <p>Ans: Baby incubator is the instrument related to NICU.</p> <div data-bbox="334 846 1377 1436" data-label="Diagram"> <pre> graph LR TS[Temperature Sensor] --> ADC[ADC] HS[Humidity Sensor] --> ADC ADC --> MC[Micro controller] MC --> LCD[LCD Display] MC --> Relay[Relay (Fan)] MC --> Triac[Triac] MC --> Buzzer[Buzzer] Triac --> Bulb[Bulb (or Heater)] </pre> </div> <p>It consists of a temperature sensor and a humidity sensor to sense temperature and humidity. The signals are then given to the ADC which will convert analog signals to digital form. Then these are given to the microcontroller. LCD display is used for display purpose which will display the temperature and humidity. Whenever Temperature rises above a threshold level at that time a Relay is turned on. There is a 12 volt DC fan at the output of Relay. Whenever Humidity rises above a threshold level, at that time microcontroller gives firing angle pulses to a Triac. Then this is connected to a heater or bulb. The intensity of bulb varies with the increase in Humidity value. The buzzer is connected which can be used in an emergency case.</p>	<p>01 M</p> <p>03 M</p> <p>02 M</p>